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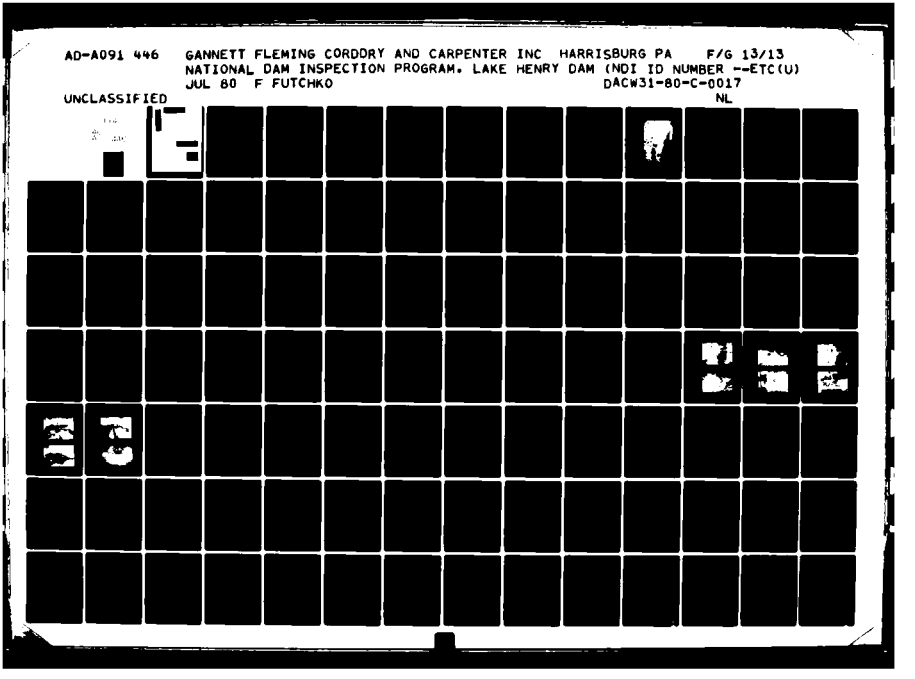

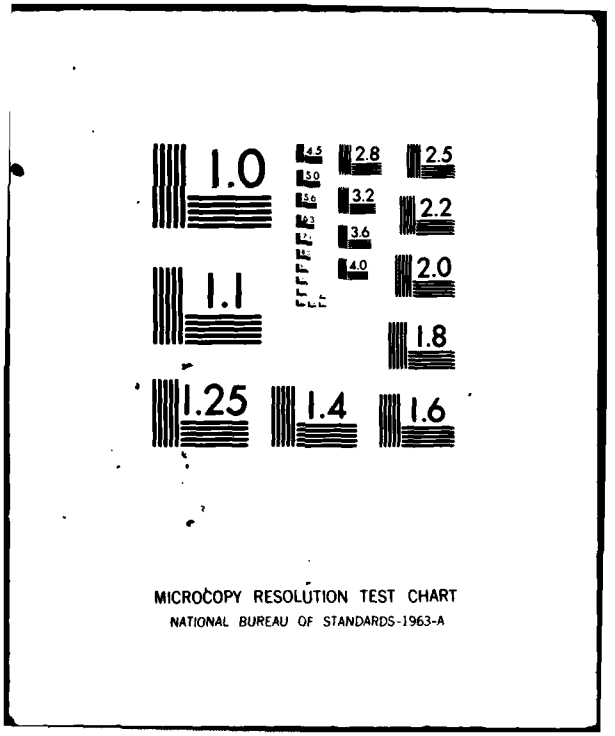
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A

DELAWARE RIVER BASIN

TRIBUTARY TO JONES CREEK, WAYNE COUNTY

PENNSYLVANIA

National Dam Inspection Program.

LAKE HENRY DAM

NDI ID ~~No.~~ Number PA-00154
DER ID ~~No.~~ Number 64-34, Delaware River Basin

~~ROBERT L. RODGERS AND HELEN K. STONER~~

Tributary to Jones Creek, Wayne County, Pennsylvania.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DACW31-80-C-0017

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

11 JULY 1980

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

DELAWARE RIVER BASIN

TRIBUTARY TO JONES CREEK, WAYNE COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00154
DER ID No. 64-34

JANET L. RODGERS AND HELEN W. STONER

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JULY 1980

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APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Lake Henry Dam NDI ID No. PA-00154 DER ID No. 64-34
Size:	Intermediate (11 feet high; 2,389 acre-ft.)
Hazard Classification:	High
Owner:	Janet L. Rodgers and Helen W. Stoner c/o Rodgers-Olver-Polley, Inc.; Agent Frank E. Rodgers, Jr., President 918 Church St. Honesdale, PA 18431
State Located:	Pennsylvania
County Located:	Wayne
Stream:	Tributary to Jones Creek
Date of Inspection:	6 June 1980

According to criteria established for these studies, Lake Henry Dam is classified as unsafe, nonemergency, because of the seriously inadequate spillway capacity, the significant seepage, and the whirlpools that have reportedly developed previously in the lake. The recommended Spillway Design Flood (SDF) for the size and hazard category of the dam is the Probable Maximum Flood (PMF). The existing spillways can pass about 19 percent of the PMF before overtopping of the dam occurs. It is judged that the dam would fail during the 1/2 PMF. Failure of the dam would increase the hazard to loss of life downstream. As a whole, the dam is judged to be in poor condition.

A potential hazard exists due to significant seepage at the toe of the dam. The whirlpools that have reportedly developed upstream of the embankment could recur and are considered a potential hazard because remedial measures performed by the Owner to prevent additional whirlpools from developing are inadequate. A thorough inspection of the dam was not possible because of brush and debris and also because of an earthfill that was being placed on the day of the inspection.

Maintenance at the dam is inadequate. There are no outlet works facilities at the dam.

The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, immediately:

(1) Clear brush, debris, and trees from on or near the dam.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Lake Henry Dam as well as the nature and extent of mitigation measures required to provide adequate spillway capacity. Take appropriate action as necessary.

(3) Perform additional studies to determine the structural stability of Lake Henry Dam. These studies should also address the effects of the seepage on the structural stability of the dam, the potential of the seepage to cause piping, and the nature and extent of measures necessary to control seepage and prevent a recurrence of whirlpools. Take appropriate action as necessary.

(4) Design and construct an outlet works capable of drawing down the Lake. Any pipe placed through the dam should be provided with an upstream closure facility.

(5) Provide means to prevent the floating islands in the lake from floating downstream and blocking the spillways.

(6) Until investigations, studies, and remedial work are completed, the Owner should monitor the condition of the dam and appurtenant structures. Take appropriate action as required should any changes in conditions occur.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams. Tree removal on or near the dam should be under the guidance of a professional engineer.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

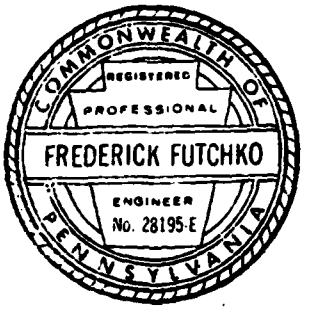
(4) Initiate an inspection program at the dam. As presently required by the Commonwealth, the inspection program should include formal annual inspections by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(5) Expand the existing maintenance program to properly maintain all features of the dam.

LAKE HENRY DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.



FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 8 August 1980

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 2 Sep 1980

LAKE HENRY DAM

Overview

DELAWARE RIVER BASIN

TRIBUTARY TO JONES CREEK, WAYNE COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00154
DER ID No. 64-34

JANET L. RODGERS AND HELEN W. STONER

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

JULY 1980

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Henry Dam is a dry stone masonry structure with an upstream earthfill. It has a main spillway and an auxiliary spillway. The dam is about 163 feet long and 11 feet high. The main spillway is at the right abutment of the dam. It has a trapezoidal-shaped section with a 24-foot long concrete weir. At the left end of the weir there is a stoplog slot with a timber stoplog in place. The crest of the weir is 1.9 feet below the top of the dam. A natural

knoll separates the main spillway from the right end of the dam. However, a concrete wall that is apparently a cutoff wall extends along the top of the dam through the natural knoll to the main spillway.

The auxiliary spillway is a notch in the top of the dry stone masonry. Its crest is 35.2 feet long and 1.8 feet below the top of the dam. There are no outlet works facilities at the dam. The various features of the dam are shown on the Photographs in Appendix C and on the Plates in Appendix E. The geology of the site is described in Appendix F.

b. Location. Lake Henry Dam is located on a tributary to Jones Creek in Lake Township, Wayne County, Pennsylvania, approximately 0.4 mile northeast of Maplewood. Lake Henry Dam is shown on USGS Quadrangle, Lake Ariel, Pennsylvania, at latitude N 41° 26' 10" and longitude W 75° 26' 35". A location map is shown on Plate E-1.

c. Size Classification. Intermediate (11 feet high; 2,389 acre-feet of which about 260 acre-feet is contained in a natural lake).

d. Hazard Classification. High Hazard. Down-stream conditions indicate that a high hazard classifica-tion is warranted for Lake Henry Dam (Paragraphs 3.1e and 5.1c (5)).

e. Ownership. Janet L. Rodgers and Helen W. Stoner, c/o Rodgers-Olver-Polley, Inc., Agent, Frank E. Rodgers, Jr. President, 918 Church St., Honesdale, Pennsylvania 18431.

f. Purpose of Dam. Recreation.

g. Design and Construction History. The Pennsylvania Water Supply Commission (PWSC) prepared a report on the dam in 1915. In that report, the PWSC researched the history of the structure. According to the PWSC, the dam was originally constructed in 1865 by farmers, apparently for recreation and ice harvesting. Other data indicates that the dam was constructed in 1878. The report indicates that the original outlet works was removed in 1913 by M. E. Keene. At that time, Mr. Keene constructed an outlet works consisting of a timber sluiceway and a timber gate. At that time, the embankment was a dry stone masonry gravity dam with timber sheeting along the upstream side. In July 1914, the dam was overtopped by 2 feet, with no reported

damage. The report prepared by the PWSC in 1915 recommended increasing the spillway capacity. By 1917, the owner had enlarged the spillway, which was at the right abutment, to the satisfaction of the PWSC. The PWSC inspected the dam several times between 1917 and 1934. Repairs were ordered at least once. A summary of the inspection history is in Appendix A. In July 1934, the dam overtopped "slightly" and the spillway weir collapsed. This caused a highway bridge downstream to wash out and severe erosion damage at a railroad bridge downstream. A new concrete weir was constructed by September 1934. As noted in Appendix A, further repairs were ordered after an inspection in 1935 by the PWSC.

The dam was modified in 1938. The timber sluiceway outlet works was removed, the timber sheeting on the upstream slope was reportedly removed, earthfill was added upstream of the dry stone masonry, and the auxiliary spillway was constructed.

In 1975, the Lake Henry Cottagers' Association, Inc. (LHCA) leased the dam from the present Owner. Their lease reportedly includes the responsibility for maintenance of the dam. The LHCA paved the auxiliary spillway with macadam and "faced the dam with concrete" in 1975. The concrete facing is apparently cosmetic, because around 1976 two whirlpools developed, at different times, in the lake adjacent to the dam. The LHCA reports that between 1976 and the present over 300 tons of crusher waste from a local quarry was placed on the upstream slope to eliminate the whirlpools and to provide a submerged access road across the dam. Construction in progress on the day of the inspection is described in Section 3.

h. Normal Operational Procedure. The pool is maintained at the main spillway crest level with excess inflow discharging over the spillways. There are no outlet works facilities. Spillway discharge flows downstream to Jones Creek.

1.3 Pertinent Data (Existing Conditions).

a. Drainage Area. (square miles) 5.9

b. Discharge at Damsite. (cfs.)

Maximum known flood at damsite	990
Outlet works at maximum pool elevation	None.
Spillway capacity at maximum pool elevation	
Main	340
Auxiliary	230
Total	570

c. Elevation. (feet above msl.)

Top of dam	1481.9
Maximum pool	1481.9
Normal pool (main spillway crest)	1480.0
Auxiliary spillway crest	1480.1
Upstream invert outlet works	None.
Downstream invert outlet works	None.
Streambed at toe of dam	1471.4

d. Reservoir Length. (miles)

Normal pool	1.6
Maximum pool	1.7

e. Storage. (acre-feet)

Natural lake	262
Normal pool	1,766
Maximum pool	2,389

f. Reservoir Surface. (acres)

Natural lake	81
Normal pool	319
Maximum pool	337

g. Dam.

Type	Dry stone masonry gravity structure with earthfill upstream.
Length (feet-approximate)	163
Height (feet)	11
Topwidth (feet)	Varies, 8 minimum.
Side Slopes	
Upstream (Record Data)	1V on 2H
Downstream	Vertical.

g.	Dam (Cont'd.)	
	Zoning	Earthfill and dry stone masonry.
	Cut-off	Unknown.
	Grout Curtain	None.
h.	Diversion and Regulating Tunnel.	None.
i.	Spillway.	
	Type	
	Main	Approximate trapezoidal-shaped section with a broad-crested concrete weir.
	Auxiliary	Broad-crested weir.
	Length of Weir (feet)	
	Main	24.0
	Auxiliary	35.2
	Crest Elevation	
	Main	1480.0
	Auxiliary	1480.1
	Upstream Channel	
	Main	Reservoir.
	Auxiliary	Reservoir.
	Downstream Channel	
	Main	Concrete apron.
	Auxiliary	Natural stream, (see Section 3).
j.	Regulating Outlets.	None.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. There are no data for the dam.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the Photographs in Appendix C and on Plates E-2 and E-3 in Appendix E.

c. Design Considerations. There are insufficient data to assess the design.

2.2 Construction.

a. Data Available. No data are available for the construction of the original dam. The only construction data are very scant data for the 1938 modification.

b. Construction Considerations. There are insufficient data to assess the construction.

2.3 Operation. There are no formal records of operation. The LHCA maintains some records of the post-1975 work performed at the dam. A record of operation does exist in the form of inspection reports prepared by the Commonwealth between 1917 and 1965. The findings of these inspections are in Appendix A.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). The Owners made available their agent for information during the visual inspection. The Lake Henry Cottagers' Association, Inc. made available their president, vice-president, and maintenance supervisor for information.

b. Adequacy. The type and amount of available design data and other engineering data are very limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data. However, much of the data is in conflict. Significant conflicts are discussed in other sections of this Report.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The overall appearance of the dam is poor. Deficiencies were observed as noted below. A sketch of the dam with the locations of deficiencies is presented on Exhibit B-1 in Appendix B. Survey information acquired for this Report is summarized in Appendix B. Datum for the survey was assumed at main spillway crest, Elevation 1480.0, as shown on USGS mapping. On the day of the inspection, the pool was at the main spillway crest.

The inspection team was accompanied by a representative of PennDER. When the inspection team arrived, the LHCA was in the process of placing fill along the downstream side of the dam. It was reported that vandals had removed some large stones from the downstream face of the dam and that the purpose of the fill was to prevent future acts of vandalism. As part of the work, the LHCA had placed fill across the entire auxiliary spillway to allow access to the other side by construction equipment. The fill is an uncompacted, silty sand with some boulders (Photographs C and G).

The PennDER representative asked the LHCA if they had a permit to perform the work. When the LHCA replied that they had no permit, the PennDER representative informed them that they were in violation of the Pennsylvania Dam Safety and Encroachments Act. He advised them to cease work. Further discussions with LHCA revealed that the fill in the auxiliary spillway was intended as a temporary measure to protect the auxiliary spillway structures from damage by hauling equipment. The PennDER representative then advised that since obtaining a permit could be a relatively lengthy process, removing the fill from the auxiliary spillway would enable it to pass its discharge capacity. When the PennDER representative and the inspection team returned from lunch, the temporary fill in the auxiliary spillway had been completely removed and all work had ceased (Photograph H).

b. Dam. Very little could be seen of the dry stone masonry. Only the right end of the downstream face of the dam was visible. It appeared to be in good

condition, although a very small bulge that is obviously not of recent origin was observed adjacent to the recently-placed earthfill below the auxiliary spillway. Some fairly large (5-foot maximum dimension) boulders are randomly located on the earthfill. The total seepage at the toe of the earthfill was about 50 gpm. The locations of seepage points are shown on Exhibit B-1. To the left of the earthfill, a slope that appears to be a natural slope extends for about 50 feet. Mature trees are growing on the slope, which is covered with massive vegetal debris. Brush and trees are also growing at the abutments and at the toe of the dam.

The auxiliary spillway is located near the center of the dam. The auxiliary spillway was obscured by a thin layer of soil (Photograph H). Macadam was observed at two locations through the soil cover. To the right of the auxiliary spillway, a concrete wall extends to the main spillway, as shown on Plate E-2. Only the top of the wall is visible. It deflects at two locations. At the deflection point nearest the main spillway, the wall is cracked and offset vertically by 0.2 foot.

The upstream side of the dam has been recently filled with crusher waste. The LHCA reported that whirlpools developed in the lake near the dam in about 1976. One whirlpool was near the main spillway. The other was just to the right of the auxiliary spillway. The crusher waste was placed both to eliminate the whirlpools and to provide a submerged access road for construction equipment, as noted in Paragraph 1.2g. The crusher waste is not well compacted adjacent to the embankment.

The survey performed for this inspection was used to draw a plan of the dam that is shown on Plate E-2. The only available drawing for the dam shows cross sections and profiles for the spillways. This drawing is shown on Plate E-3. Using Plate E-3 as a guide, the embankment is 0.2 foot below its design elevation. A profile of the dam is shown in Appendix B.

c. Appurtenant Structures. The main spillway is at the right abutment of the dam. A stoplog that extends partially along the crest is mortared into the stoplog slot. The crusher waste placed along the upstream side of the dam is level with the top of the weir and stoplog. The right end of the weir is covered with crusher waste and the left end is covered with earthfill. The ends of the weir are therefore not distinct. The concrete apron

that is downstream of the weir is a thin paving that covers a stone and concrete-rubble fill. A hole about 2 inches in diameter that was eroded into the paving allows water to flow through. There is about a 1-foot drop between the end of the apron and the streambed. The end is unprotected and erosion has occurred at the end of the apron. Bedrock is visible in the main spillway channel.

The auxiliary spillway is described in Paragraph 3.1b. There is no outlet works at the dam. The left abutment of the dam is very flat and heavily wooded.

d. Reservoir Area. The watershed is mostly rolling hills with minor rural development. The western edge of the watershed is mountainous and steep. There are 3 dams within the watershed, as noted in Appendix D. The right shore of the reservoir has mild slopes; the left shore is fairly steep. The LHCA pointed out what appeared to be islands in the lake. They stated that these are floating islands, or masses of vegetal matter with trees growing thereon. One of these islands is just upstream of the left abutment of the dam. It was reported that it drifted into the cove to the right of the main spillway and was towed to its present location. At present, this island is secured by aerial cable to the shore. The other islands in the lake are not secured to the reservoir bottom or the shore.

e. Downstream Channel. The main spillway channel joins the auxiliary spillway channel about 100 feet downstream from the dam. The banks of both channels are steep and wooded. Some evidence of minor erosion was observed at the banks. From the dam, the stream flows for about 0.4 mile where it crosses under two roads. The stream then flows for another 0.4 mile to the remains of an old mill dam, which is breached. The stream is steep and narrow in the above reach. Just upstream of the remains of the mill dam is a bridge. One dwelling is at the right bank of the stream near the above bridge. The stream then flows for 0.1 mile into an extensive swamp. The stream is known as Jones Creek from this point downstream. Where the stream flows into the swamp, there is a low-lying dwelling adjacent to the stream. The swamp extends downstream for 2.2 miles. There are no low-lying dwellings near the swamp. At the downstream end of the swamp, the stream flows under PA Route 348 (PA-348). Near PA-348 are 3 additional dwellings that could be flooded by a failure of the dam. Downstream conditions are shown on Exhibit D-1.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at the main spillway crest level with excess inflow discharging over the main and auxiliary spillways and into the downstream channel. There are no outlet works facilities.

4.2 Maintenance of Dam. The LHCA maintenance supervisor visits the dam daily, except during the winter. The dam is not visited during the winter. The maintenance work performed by the LHCA is described in Sections 1 and 3.

4.3 Maintenance of Operating Facilities. There are no operating facilities at the dam. The LHCA maintenance foreman stated that he would remove the stoplog with an axe if the lake rose to near the top of the dam.

4.4 Warning Systems in Effect. There is no emergency operation and warning system.

4.5 Evaluation of Operational Adequacy. The maintenance of the embankment and spillways is poor, as discussed in Sections 5 and 6. The method of removing the stoplog is unreliable because access to it would be difficult during high pool conditions. Inspections are necessary to detect hazardous conditions at the dam. An emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There are no design data. The addition of the auxiliary spillway in 1938 was never analyzed by the Commonwealth. The work was performed without a permit, although the Commonwealth had no objections to the modifications as completed in 1938.

b. Experience Data. The reported flood of record occurred in July 1914, when the dam overtopped by 2 feet. The Pennsylvania Water Supply Commission estimated the flow as 990 cfs. This is further discussed in Paragraph 5.1d (5). No data are available to estimate the flow for the flood of July 1934, when the spillway weir washed out.

c. Visual Observations.

(1) General. The visual inspection of Lake Henry Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics. These observations are evaluated herein for the various features.

(2) Dam. There were no significant observations relevant to hydrology and hydraulics for the dry stone masonry section of the dam. Observations on the dry stone masonry pertain to structural stability and are evaluated in Section 6.

(3) Appurtenant Structures. After the recently-placed earthfill had been removed from the auxiliary spillway, no deficiencies were observed at the auxiliary spillway. The main spillway weir is in good condition. The deterioration of the spillway apron is not a major hazard to the dam at present. However, if the eroded areas are not repaired, further erosion is likely. Structural details of the main spillway weir are not available. From descriptions in the records, it is implied that the main spillway weir relies upon the rubble downstream of the weir for support. Thus, further erosion of the rubble downstream of the weir is of concern. The ends of the main spillway weir are not distinct. As shown on the profile in Appendix B, the main spillway has been assumed to include the overbank at the right end and part

of the natural knoll at the left end. Although the brush and trees in this area would reduce the main spillway capacity, the effects of the brush and trees have not been included in the analysis described hereafter.

Since there are no outlet works facilities, there is no effective means of drawing down the lake in in case of emergency.

(4) Reservoir Area. The development in the watershed is minor. Pertinent data concerning Half Moon Lake Dam and Kizer Pond Dam are in Appendix D. A profile of each dam is in Appendix B. The spillway at Half Moon Lake Dam is completely blocked by debris (Photograph J). The pool is maintained below spillway crest by seepage through the dam. For the analysis described hereafter, the pool was assumed to be maintained at the water level existing on the day of the inspection. Since the spillway is blocked, only flow over top of the dam is considered. The effects of Half Moon Lake have been included in the analysis only because they may affect the runoff. A failure of Half Moon Lake Dam would not present a significant hazard to Lake Henry Dam.

The effects of Kizer Pond Dam have also been included in the analysis. A road extends parallel to and just downstream from the axis of the dam (Photograph I). For the purposes of this study, it is assumed that the higher of either the road or the top of the dam controls. This is shown on the profile in Appendix B. However, some flow over the top of the dam would be directed along the downstream toe. This condition was not modelled. Plate E-1 shows an outlet along the right shore of Kizer Pond Dam. This outlet was observed during the inspection and is judged not to provide significant discharge capacity. It is a natural low area that is covered wtih thick brush.

Spillway flow immediately downstream from Kizer Pond Dam flows into a culvert under the road and then into Kizer's Little Pond, which is impounded by a 10-foot high embankment. The effects of Kizer's Little Pond, which has negligible storage, have been ignored.

(5) Downstream Conditions. No conditions were observed downstream that would reduce the hydraulic capacity of the spillways. A failure of the dam would flood 2 dwellings within 1 mile of the dam. Although the swamp along Jones Creek would have significant mitigating effect on discharge resulting from dam failure, the bridge at the downstream end of the swamp would act as a

small dam. A failure of Lake Henry Dam would cause a large volume of water to flow downstream. This would probably cause the roadway and bridge at the downstream end of the swamp to overtop, with the resultant flooding of 3 additional dwellings. The downstream conditions indicate that a high hazard classification is warranted for Lake Henry Dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (Intermediate) and hazard potential (High) of Lake Henry Dam is the Probable Maximum Flood (PMF). The watershed was modeled with the HEC-1DB computer program. A description of the model is included in Appendix D. The assessment of the hydrology and hydraulics is based on existing conditions, and the effects of future development are not considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that Lake Henry Dam can pass about 19 percent of the PMF before overtopping of the dam occurs. The dam is rated at its existing top elevation. Raising the top of the dam to its reported design elevation would make negligible difference in the spillway capacity. The analysis also reveals that Half Moon Lake Dam and Kizer Pond Dam can pass 9 percent and 20 percent, respectively, of their components of the PMF.

(3) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix D. During the 1/2 PMF, the dam will overtop by 2.2 feet for 19 hours. The flood of record at the dam occurred on 10 July 1914 when, according to the Pennsylvania Water Supply Commission, "as much as 2 feet of water passed over the sheeting during a cloudburst." No duration is noted. The reference to sheeting is to the timber sheeting that then extended along the upstream side of the dry stone masonry and protruded above the top of the masonry. Neither the source of the data concerning the overtopping nor the method of determining the depth of overtopping is noted. Although the dam could probably withstand shallow overtoppings, it is judged that the dam could not withstand the depth and duration of overtopping that would occur during the 1/2 PMF. Although the dry stone masonry at the top of the dam might withstand the velocities that would occur during the overtopping, the toe of the dam would be

subject to scour which could cause the dam to fail. As noted in Section 6, foundation conditions at the dam are unknown. As shown on Plate E-3, a previous owner of the dam placed rubble and debris on the downstream side of the auxiliary spillway. It is believed that this indicates that scour had either occurred or was anticipated. It is therefore assumed that the dam would fail during an occurrence of the 1/2 PMF. Assumptions used to model the breach are listed in Appendix D. The resulting flows were routed downstream. The results indicate that a failure of the dam would increase the water level near dwellings between 2.0 to 3.7 feet over the stream depth that would occur if the dam were not to fail. There is an increased hazard to loss of life. The bridges extending across the stream were not considered in the model. Their effects would increase the hazard. The spillway capacity of Lake Henry Dam is rated as seriously inadequate.

As part of this study, the effects of a failure of Kizer Pond Dam during the 1/4 and 1/2 PMF were determined. During either storm, a failure of Kizer Pond Dam would have negligible effect on Lake Henry Dam. It was assumed that Kizer Pond Dam would be breached down to the elevation of the low elevation of the top of the road that is just downstream and parallel to the axis of the dam.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Lake Henry Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Dam. The growth of trees on or near the dam is a hazard to the structure. Root systems can loosen material that make up the dam and create paths along which seepage and piping (internal erosion) might occur. Brush and debris are objectionable because they obscure the dam and hinder visual inspection.

The uncompacted earthfill that was being placed on the day of inspection does not structurally harm the dam. It was being placed on an unstripped foundation. The downstream slope was the angle of repose of the fill; the survey performed for this inspection reveals that the slope is about 1V on 1.25H. The LHCA maintenance supervisor stated that the LHCA eventually planned to place riprap on the slope, but no riprap was stockpiled at the site. In its present condition, the earthfill would erode rapidly during either heavy rain or periods of auxiliary spillway flow. The earthfill is very objectionable because it obscures most of the dam and the location of the seepage. Although it is not pertinent to the safety of the dam, the earthfill also presents environmental and personnel hazards.

A thorough inspection of the dam was not possible because most of the dam was obscured either by the recently placed earthfill or by brush and debris. This is further discussed in Paragraph 6.1b.

(3) Appurtenant Structures. The minor maintenance deficiencies at the main spillway are evaluated in Section 5. No deficiencies were observed at the auxiliary spillway, as noted in Section 5.

b. Design and Construction Data. A review of the photographs in the PennDER files reveals some data

pertinent to the dam. The photographs were mostly taken during the periodic inspections performed by the Commonwealth. A previous owner also submitted a set of photographs. Although undated, they are believed to have been taken in 1951, when a drawing (Plate E-3) was submitted to the Commonwealth.

Judging by photographs taken in 1915 and 1938, the dry stone masonry appears to extend about 10 to 20 feet beyond the point described by the maintenance supervisor. The 1951 photographs show an upstream concrete wall extending about 20 feet to the left of the auxiliary spillway. Plate E-2 shows a slope extending about 50 feet to the left of the auxiliary spillway. It is fairly certain that the dry stone masonry extends at least 20 feet beyond the left end of the auxiliary spillway; it may extend up to 50 feet. If it does not, then the natural slope acts as an embankment and there would be concern for its slopes and composition. The downstream slope is covered by massive vegetal debris and large trees. The inspection team could not determine what portions of the area to the left of the auxiliary spillway were natural or manmade.

The foundation conditions at the embankment are unknown. Bedrock outcrops at the main spillway, but no bedrock was observed near other areas of the dam. As noted in Section 5, rubble and debris were placed at the toe of the dam, which is believed to indicate that scour was either anticipated or was previously a problem. The rubble and debris may be under the recently placed earthfill.

The PWSC Report of 1915 describes the dam as rockfill (dry stone masonry) with timber sheeting upstream. Photographs taken in 1930 and 1937 show earthfill and rockfill placed on the upstream side of the sheeting. Plate E-3 indicates that by 1938, a significant amount of fill had been placed upstream of the sheeting. This Plate also indicates that the sheeting had been removed in 1938. As the removal of the sheeting would have required excavation of the upstream earthfill, it is surmised that only the upper, exposed portion of the sheeting was removed and replaced by a concrete wall. The LHCA has since placed more crusher waste on the upstream side of the embankment.

The seepage at the dam is of concern because it is uncontrolled and the quantity has apparently increased significantly since the dam was last inspected. Previous inspection reports only note a minor amount of seepage.

Because of the recently-placed earthfill on the downstream side of the dam, the exact location of the seepage could not be determined on the day of the inspection. The LHCA maintenance foreman stated that when the lake falls during the summer, the seepage reduces to a trickle. The top of the sheeting is subject to fluctuating pool levels. It is therefore surmised that the timber sheeting is deteriorating with most of the deterioration having occurred at the top of the sheeting. This would explain the reported large variation of seepage with a relatively minor variation in pool elevation.

The deterioration of the sheeting could have caused the whirlpools, which appeared around 1976. The measures taken to prevent the recurrence of the whirlpools are, at best, temporary. It is believed that present conditions are still conducive to other whirlpools developing. Uncontrolled seepage could develop into piping, as indicated by whirlpools, and lead to rapid failure of the dam.

The theoretical structural stability of the dam cannot be determined without further information because both the extent of the dry masonry in the dam and the foundation conditions are unknown.

c. Operating Records. There are no formal records of operation. The development of whirlpools and the significant increase in seepage, as assessed above, are of major concern. There are no records of any slope movement over the operational history of the dam.

d. Post-Construction Changes. The various modifications to the dam are evaluated above.

e. Seismic Stability. Lake Henry Dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone has adequate factors of safety under static loading conditions, it can be assumed safe for any expected earthquake loading. However, since there are no static stability analyses, the theoretical seismic stability of Lake Henry Dam cannot be assessed.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on available records, visual inspection, calculations, and past operational performance, Lake Henry Dam is judged to be in poor condition. The recommended SDF for the size and hazard category of the dam is the PMF. Based on existing conditions, the spillways will pass about 19 percent of the PMF before overtopping of the dam occurs. It is judged that the dam would fail during the 1/2 PMF. Failure of the dam would cause an increased hazard for loss of life downstream. The spillway capacity is rated as seriously inadequate.

(2) There was no evidence of slope movement at the dam at the time of the visual inspection. A potential hazard exists due to the significant amount of uncontrolled seepage at the toe of the dam and due to the whirlpools that have reportedly developed upstream of the dam. Remedial measures performed by the Owner to prevent additional whirlpools from developing are inadequate.

(3) According to criteria established for these studies, the dam is classified as unsafe, nonemergency, because of the seriously inadequate spillway capacity, the significant seepage, and the whirlpools that have reportedly developed previously in the lake.

(4) Maintenance at the dam is inadequate.

(5) There are no outlet works facilities at the dam.

(6) A summary of the features and observed deficiencies is listed below:

Feature and Location	Observed Deficiency
Embankment:	Brush and trees; seepage.
Main Spillway:	Eroded areas in apron and at downstream end of apron; brush and trees.
Reservoir Area:	Floating islands with a potential to block spillways.

b. Adequacy of Information. The information available is such that a preliminary assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study. However, brush, debris, and earthfill at the downstream toe of the dam obscured most of the dam; as a result, a thorough inspection of the dam was not possible.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented immediately.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by the Owner will be required.

7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures are recommended to be undertaken by the Owner, in approximate order of priority, immediately:

(1) Clear brush, debris, and trees from on or near the dam.

(2) Perform additional studies to more accurately ascertain the spillway capacity required for Lake Henry Dam as well as the nature and extent of mitigation measures required to provide adequate spillway capacity. Take appropriate action as necessary.

(3) Perform additional studies to determine the structural stability of Lake Henry Dam. These studies should also address the effects of the seepage on the structural stability of the dam, the potential of the seepage to cause piping, and the nature and extent of measures necessary to control seepage and prevent a recurrence of whirlpools. Take appropriate action as necessary.

(4) Design and construct an outlet works capable of drawing down the Lake. Any pipe placed through the dam should be provided with an upstream closure facility.

(5) Provide means to prevent the floating islands in the lake from floating downstream and blocking the spillways.

(6) Until investigations, studies, and remedial work are completed, the Owner should monitor the condition of the dam and appurtenant structures. Take appropriate action as required should any changes in conditions occur.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams. Tree removal on or near the dam should be under the guidance of a professional engineer.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system.

(4) Initiate an inspection program at the dam. As presently required by the Commonwealth, the inspection program should include formal annual inspections by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(5) Expand the existing maintenance program to properly maintain all features of the dam.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: LAKE HENRY DAM

NDI ID NO.: PA-00154 DER ID NO.: 64-34

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	ONLY AVAILABLE DRAWING IS PLATE E-3
REGIONAL VICINITY MAP	SEE PLATE E-1
CONSTRUCTION HISTORY	PROBABLY BUILT 1865 BUT OTHER DATA INDICATES 1878 OR 1916
TYPICAL SECTIONS OF DAM	SEE PLATE E-3
OUTLETS: Plan Details Constraints Discharge Ratings	NO OUTLET AT SITE

A-1

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	NONE
DESIGN COMPUTATIONS: Hydrology and Hydraulics (H&H) Dam Stability Seepage Studies	NONE EXCEPT SOME SPILLWAY CAPACITY CALCULATIONS BY PWSC.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	SEE PLATES E-2 AND E-3

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	UNKNOWN
MONITORING SYSTEMS	NONE
MODIFICATIONS	1913 - OUTLET WORKS REPLACED 1938 - OUTLET WORKS REMOVED, AUXILIARY SPILLWAY CONSTRUCTED, UPSTREAM EARTHFILL ADDED
HIGH POOL RECORDS	JULY 1914 - OVERTOPPED by 2'. PWSC ESTIMATE 990CFS JULY 1984 - WATER OVERTOPPED dam SLIGHTLY, SPILLWAY WEIR FAILED, NO DISCHARGE ESTIMATE. MAY 1942 - PWSC ESTIMATE 860CFS, WATER AT TOP
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	NONE
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	JULY 1934 - SPILLWAY WEIR FAILED CIRCA 1976 - WHIRLPOOLS developed IN RESERVOIR. PWSC REPORT ON 1934 SPILLWAY FAILURE.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	LAKE HENRY COTTAGERS' ASSOCIATION KEEPS RECORDS OF MATERIAL USED AT DAM. RECORDS DATE FROM 1975.
SPILLWAY: Plan Sections Details	SEE PLATES E-2 AND E-3.
OPERATING EQUIPMENT: Plans Details	NONE
PREVIOUS INSPECTIONS Dates Deficiencies	1917 - NO LEAKAGE, RECOMMENDATIONS FROM 1915 PWSC REPORT HAVE BEEN ACCOMPLISHED, SPILLWAY CLEAR. 1919 - SLIGHT LEAKAGE FROM LEFT END, UPSTREAM TIMBER SHEETING UNDER REPAIR, SPILLWAY OBSTRUCTED. 1924 - LEAKAGE UNDER AND AROUND ENDS OF SPILLWAY. 1930 - TOP OF DAM IS LOW IN MIDDLE AND UNEVEN. BRUSH GROWING ON RIGHT END.
(CONTINUED)	THE UPSTREAM FILL ALONG THE SHEETING CUTOFF IS LOW. TOP OF DOWNSTREAM WALL OVERHANGS SEVERAL INCHES. SOME SETTLEMENT TO THE LEFT OF THE SPILLWAY.

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (CONTINUED)	1930 (CONTINUED): THERE IS CONSIDERABLE LEAKAGE AT LEFT END AND CONSIDERABLE THROUGH THE WALL AT THE SLUICE GATES, WHEN OPEN. BRUSH AND FLASHBOARD PINS IN SPILLWAY. REPAIRS ORDERED
(CONTINUED)	1931 - REPAIRS COMPLETED SATISFACTORILY. THE ONLY DEFICIENCY IS A LOG BOOM IN SPILLWAY. JULY 1934 - RECOUNTS FAILURE OF SPILLWAY WEIR.
	SEPT. 1934 - SPILLWAY REPAIRED SATISFACTORILY 1935 — TOP OF DAM IS UNEVEN AND STONES ARE MISSING FROM THE DOWNSTREAM FACE. CONSIDERABLE LEAKAGE IN "OLD CRIBBING"
	FLASHBOARDS ON SPILLWAY CREST. REPAIRS ORDERED. 1937. REPAIRS NOT ACCOMPLISHED, FLASHBOARD PINS FILLED WITH CONCRETE, STONES IN FACE OF DAM MISSING, TIMBER IN SLUICE GATE IN POOR CONDITION.
	1938 - NOTES MODIFICATIONS - NO DEFICIENCIES 1939 - NO DEFICIENCIES 1948 — DEBRIS IN SPILLWAYS. 1951 - GOOD CONDITION EXCEPT SOME LEAKAGE AT LEFT DOWNSTREAM TOE
	1965 - "WASTEWAY CHANNEL" CLUTTERED WITH LARGE TREES, BLOCKING FLOW DOWNSTREAM.

A-5

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: LAKE HENRY County: WAYNE State: PENNSYLVANIA

NDI ID No.: PA-00154 DER ID No.: 64-34

Type of Dam: DRY STONE MASONRY W/UPSTREAM EARTHFILL Hazard Category: HIGH

Date(s) Inspection: 6 JUNE 1980 Weather: CLEAR Temperature: 75°Ft

SOIL CONDITIONS: MOIST

Pool Elevation at Time of Inspection: 1480.0 msl/Tailwater at Time of Inspection: 1471.4 msl

Inspection Personnel:

P. RODGERS (REP OF OWNER), J. REESE (PRES-LHCA) J. CHERNESKY (PENNDER)

J. HARTLAND (MAINT. SUPERVISOR-LHCA) D. WILSON (GFCC)

R. SAUERS (V.P.-LHCA) & OTHER MEMBERS LHCA D. EBERSOLE (GFCC)

A. WHITMAN (GFCC) Recorder

B-1

CONCRETE/MASONRY DAMS DRY STONE MASONRY WITH UPSTREAM EARTHFILL.

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	SEE AUXILIARY SPILLWAY	
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	RIGHT ABUTMENT - NO DEFICIENCIES LEFT ABUTMENT - obscured by VEGETAL debris	Brush on dam. Brush AND TREES ADJACENT TO TOE.
DRAINS	NONE AT SITE	
WATER PASSAGES	NONE AT SITE	
FOUNDATION	No bedrock observed	

B-2

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: Surface Cracks Spalling	Not Applicable	
STRUCTURAL CRACKING	None Observed	
ALIGNMENT: Vertical Horizontal	VERTICAL- See Plate E-2 and profile following inspection forms	Horizontal: Concrete wall extends from Aux. spillway to main spillway. Wall deflects slightly at two locations
MONOLITH JOINTS	Wall noted in "Alignment" above is cracked through and offset at deflection point nearest main spillway.	
CONSTRUCTION JOINTS	Not Applicable	
STAFF GAGE OR RECORDER	None at site	

BIW

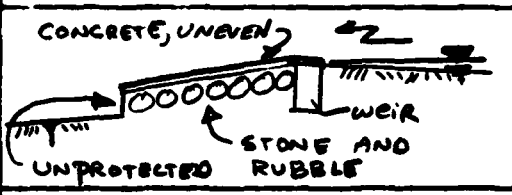
OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	NONE AT SITE	
INTAKE STRUCTURE		
OUTLET STRUCTURE		
OUTLET CHANNEL		
EMERGENCY GATE	NONE AT SITE	

UNGATED SPILLWAY (MAIN)

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	GOOD CONDITION	WOODEN STOPLOG SECURED BY CONCRETE ALONG LEFTMOST PART OF WEIR.
APPROACH CHANNEL	RESERVOIR UPSTREAM EARTHFILL IS ALMOST FLAT AND EXTENDS UP TO WEIR CREST EL.	
DISCHARGE CHANNEL	STONE AND RUBBLE COVERED BY CONCRETE. SEE SKETCH. HOLES IN CONCRETE PAVING ALLOW WATER TO FLOW BENEATH.	
BRIDGE AND PIERS	NONE	
VEGETATION	BRUSH AT BOTH LEFT AND RIGHT ENDS OF SPILLWAY	THIS WOULD REDUCE THE DISCHARGE CAPACITY.

UNGATED ~~GATED~~ SPILLWAY (AUXILIARY)

Sheet 1 of 1

The AUXILIARY SPILLWAY is A NOTCH IN THE dry MASONRY dam.

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Paved with MACADAM Reportedly CONCRETE SLAB ABOVE DRY MASONRY.	UPON ARRIVAL AT THE SITE, EARTHFILL COMPLETELY BLOCKED THE AUXILIARY SPILLWAY AND WAS
APPROACH CHANNEL	RESERVOIR. NEARLY FLAT EARTHFILL EXTENDS UPSTREAM FROM CREST.	being PLACED ALONG The downstream SIDE OF THE dry MASONRY. By THE END OF THE
DISCHARGE CHANNEL	AT PRESENT, UNCOMPACTED EARTHFILL	INSPECTION, THE AUXILIARY SPILLWAY HAD been CLEARED. See SECTION 3. There WAS TOTAL SEEPAGE
BRIDGE AND PIERS	NONE AT SITE	OF ABOUT 50gpm FLOWING FROM THE TOE OF THE FILL, AS SHOWN ON Exhibit B-1.
GATES AND OPERATION EQUIPMENT	NONE AT SITE.	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE AT SITE	
OBSERVATION WELLS		
WEIRS		
PIEZOMETERS		
OTHER	NONE AT SITE	

DOWNSTREAM CHANNEL

Sheet 1 of 1

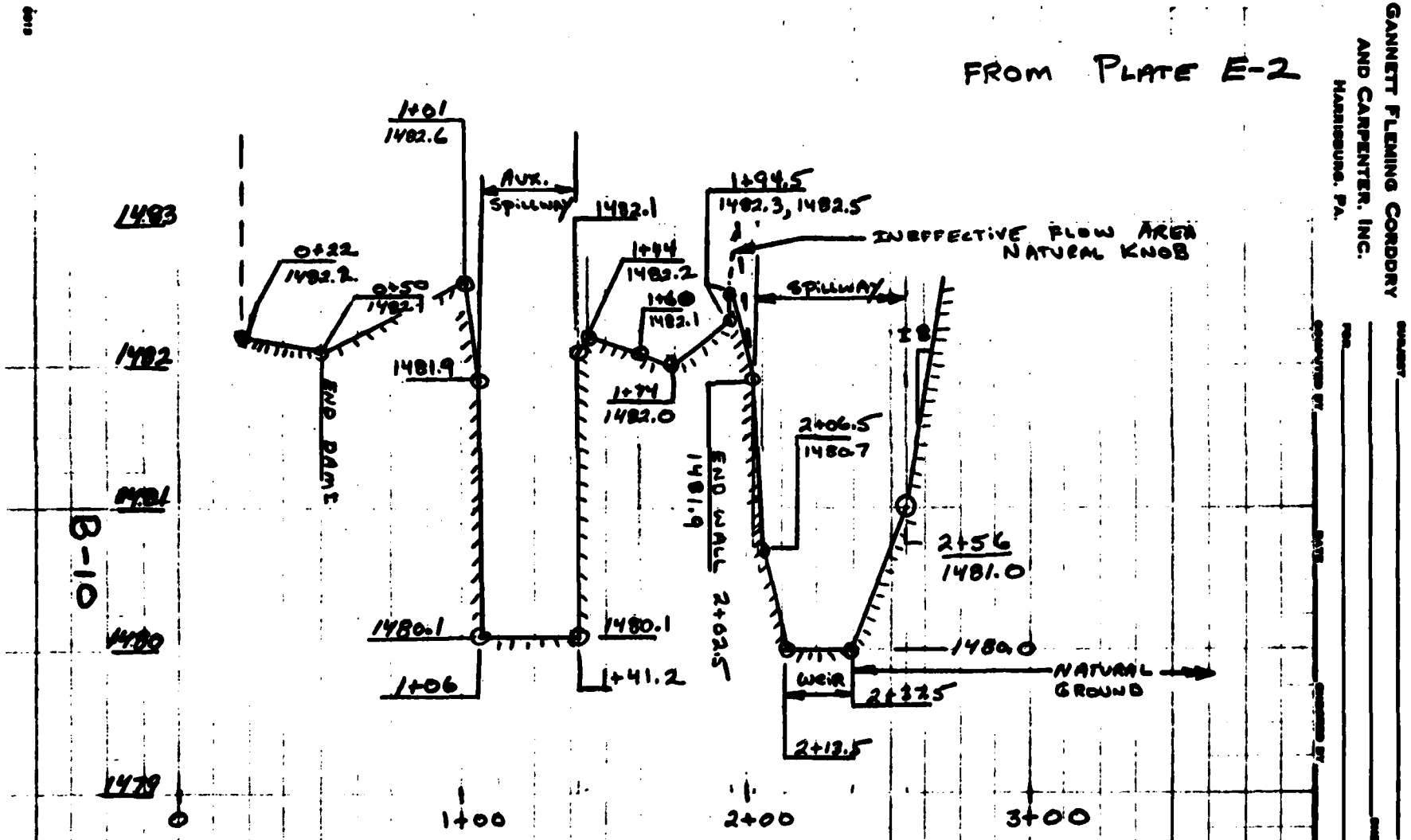
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: **Obstructions** **Debris** **Other**	NONE AT DAMSITE	
SLOPES	STEEP FOR 0.8 MILE DOWNSTREAM, THEN VERY FLAT FOR ABOUT 2 MILES	
APPROXIMATE NUMBER OF HOMES AND POPULATION	5 DWELLINGS, AS SHOWN ON EXHIBIT B-1	

B-8

RESERVOIR AND WATERSHED

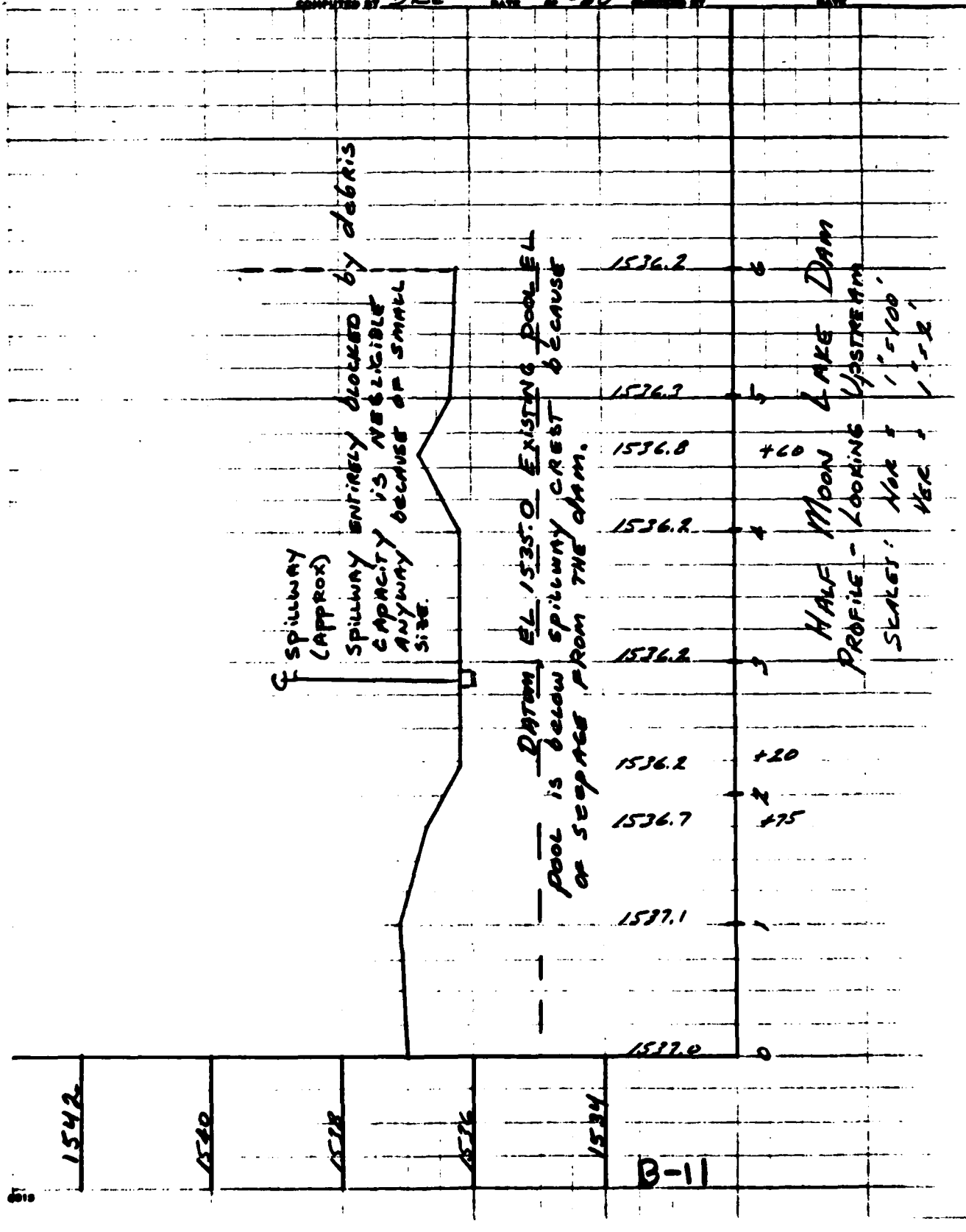
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	WATERSHED: ROLLING HILLS, EXCEPT WESTERN EDGE IS STEEP. SOME SWAMPS IN VALLEYS	RELATIVELY MILD SLOPES AT LAKE.
SEDIMENTATION	No observed problems.	
WATERSHED DESCRIPTION	MINOR RURAL development FOR dams IN WATERSHED, See APPENDIX D.	
ISLANDS	THERE ARE MANY "FLOATING ISLANDS" IN THE LAKE.	The "FLOATING ISLAND" NEAREST THE dAM IS SECURED WITH WIRE TO THE SHORE. THE OTHER ISLANDS ARE NOT SECURED.


FROM PLATE E-2
1483
1482
1481
1480
1479
B-10
0+22
1482.2
0+50
1482.7
END BANK
1+01
1482.6
1481.9
AUX. Spillway
1482.1
1+44
1482.2
1+60
1482.1
1+74
1482.0
END WALL 2+02.5
1480.1
1480.1
1+06
1+41.2
1+94.5
1482.3, 1482.5
INEFFECTIVE FLOW AREA
NATURAL KNOB
SPILLWAY
2+06.5
1480.7
2+56
1481.0
1480.0
NATURAL GROUND
WEIR
2+32.5
2+12.5
1+00
2+00
3+00
LAKE HENRY DAM
PROFILE - LOOKING DOWNSTREAM
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

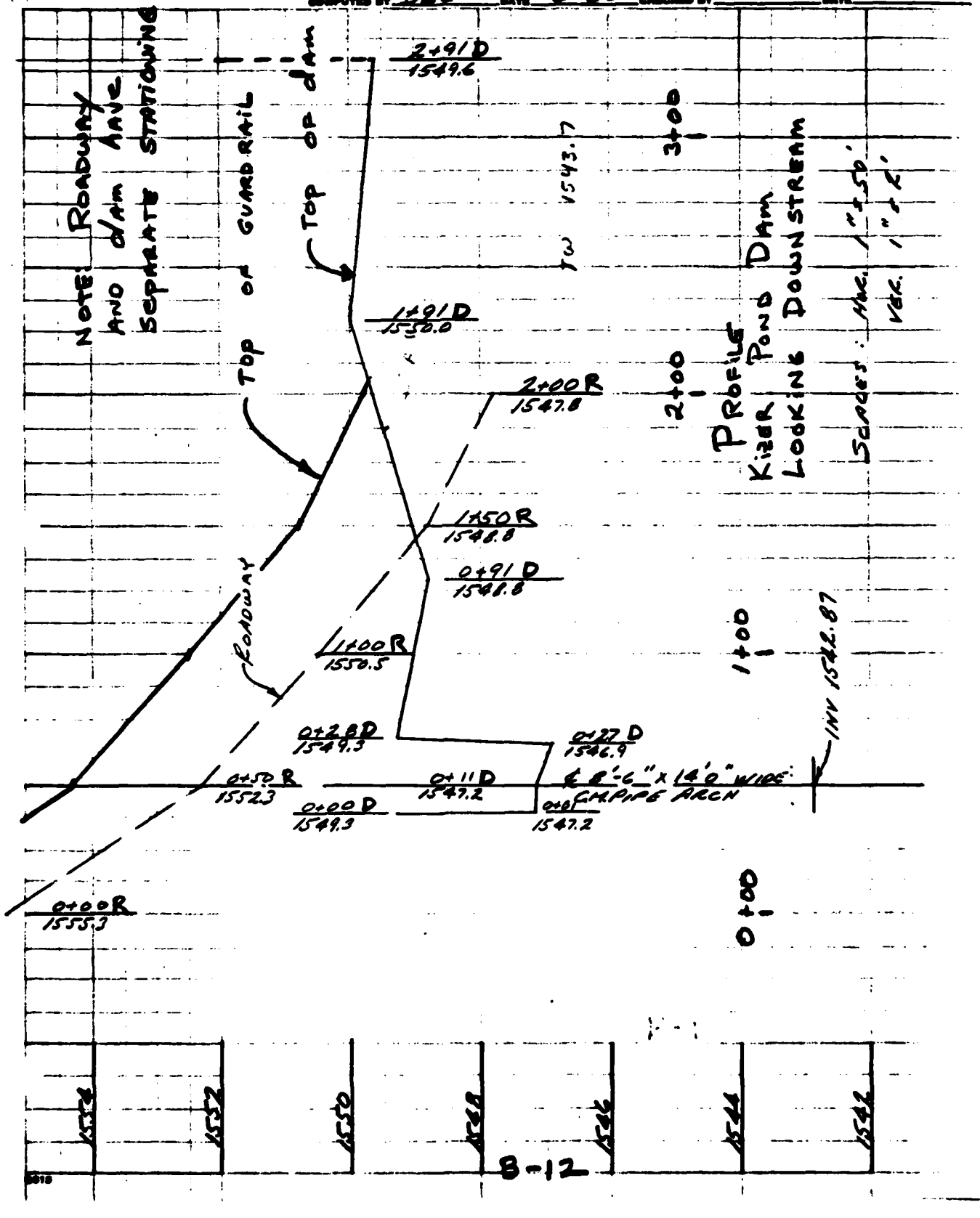
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

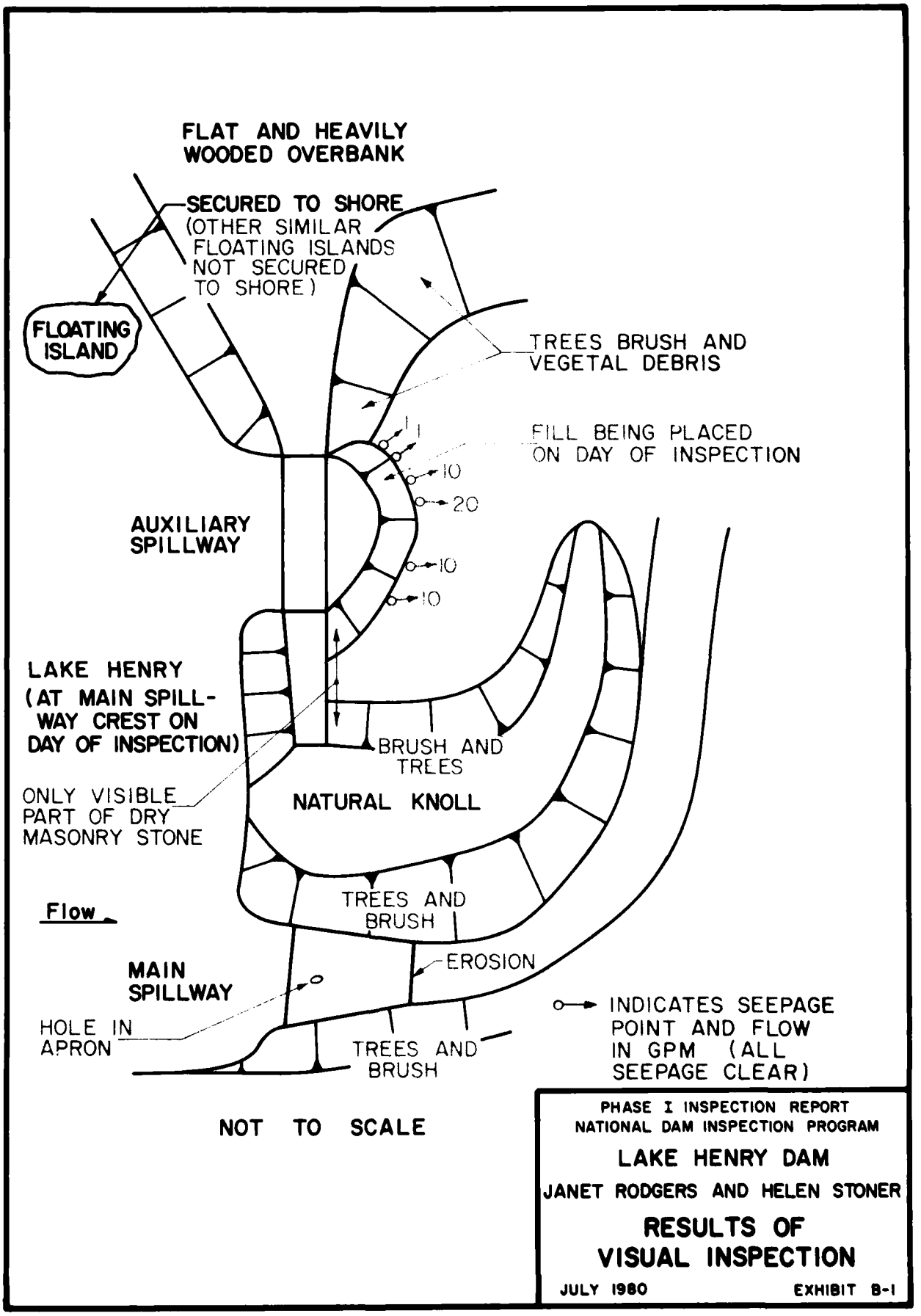
SUBJECT PROFILE - HALF MOON LAKE DAM FILE NO. 8202
SHEET NO. ____ OF ____ SHEETS
FOR
COMPUTED BY DLE DATE 6-80 CHECKED BY DATE



GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT Profiles - Kizer Pond Dam & Roadway D.S. FILE NO. 8202
SHEET NO. ____ OF ____ SHEETS
FOR
COMPUTED BY DLE DATE 6-80 CHECKED BY ____ DATE ____





PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

JANET RODGERS AND HELEN STONER

RESULTS OF VISUAL INSPECTION

JULY 1980 EXHIBIT B-1

APPENDIX C

PHOTOGRAPHS

LAKE HENRY DAM

A. Upstream Slope

B. Downstream Slope

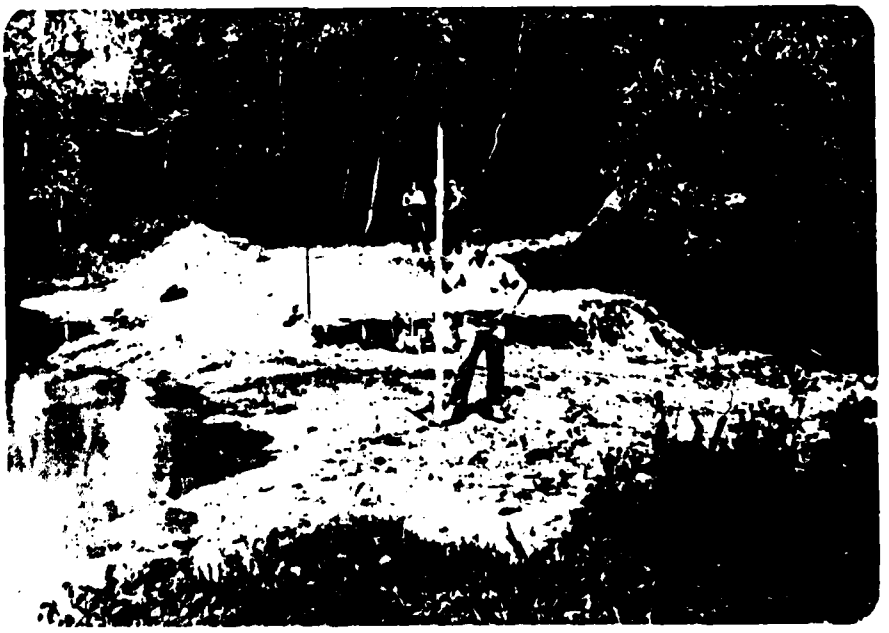
C. Downstream Slope at Auxiliary Spillway

D. Toe of Downstream Slope

E. Main Spillway

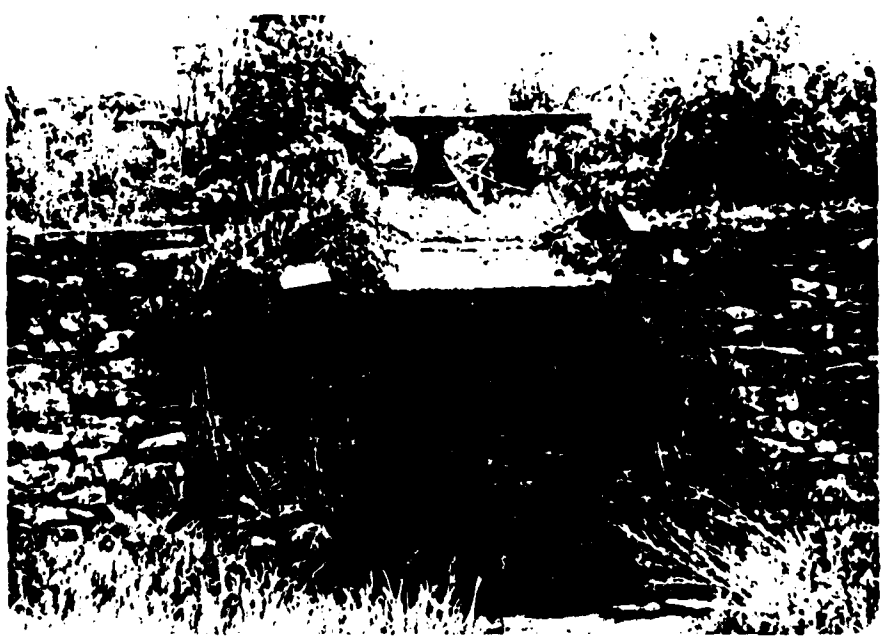
F. Main Spillway Apron

G. Auxiliary Spillway at Start of Inspection



H. Auxiliary Spillway at End of Inspection

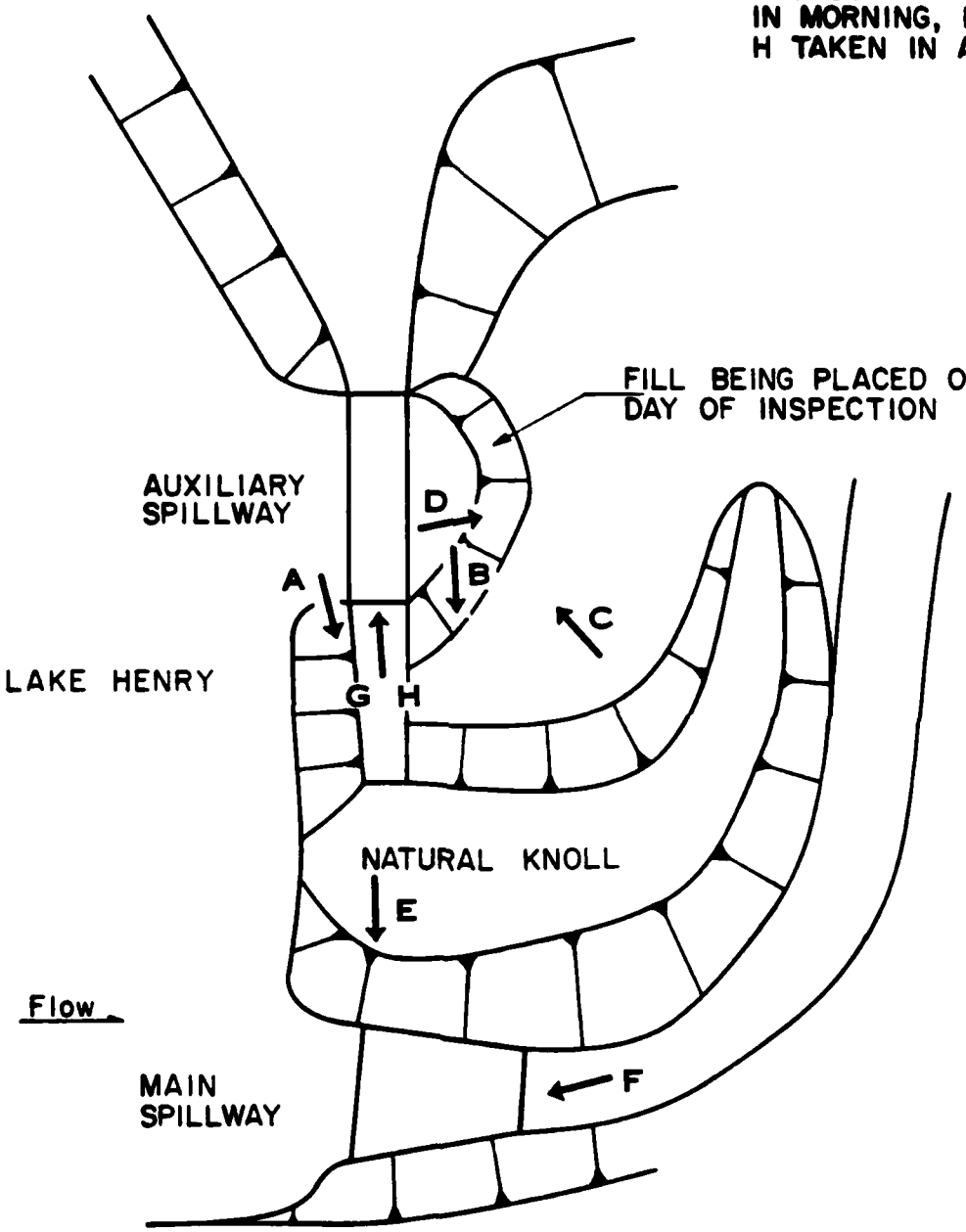
I. Kizer Pond Dam - Upstream of Lake Henry



J. Half Moon Lake Dam - Upstream of Lake Henry

NOTE:

PHOTOGRAPH G TAKEN IN MORNING, PHOTOGRAPH H TAKEN IN AFTERNOON.



NOT TO SCALE

← LOCATION AND ORIENTATION OF CAMERA

A PHOTOGRAPH IDENTIFICATION LETTER

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

JANET RODGERS AND HELEN STONER

GUIDE TO LOCATION OF PHOTOGRAPHS

JULY 1980 EXHIBIT C-1

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D

HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

DELAWARE River Basin
Name of Stream: TRIBUTARY TO JONES CREEK
Name of Dam: LAKE HENRY DAM
NDI ID No.: PA-00154
DER ID No.: 64-34
Latitude: N 41° 26' 10" Longitude: W 75° 26' 35"
Top of Dam Elevation: 1481.9 (EXISTING)
Streambed Elevation: 1471.4 Height of Dam: 11 ft
Reservoir Storage at Top of Dam Elevation: 2,389 acre-ft
Size Category: INTERMEDIATE
Hazard Category: HIGH (see Section 5)
Spillway Design Flood: PMF

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
HALF MOON LAKE	0.8	11	102	NO DER ID
KIZER POND	1.9	6	350	DER ID 35-45
KIZER'S LITTLE LAKE	2.0	10±	10±	DER ID 35-86, IGNORED IN ANALYSIS, 34-45 FLOWS INTO 35-86

DOWNSTREAM DAMS

LABAR DAM	0.7	15±	BREACHED	DER ID 64-116 IGNORED IN ANALYSIS

DELAWARE River Basin

Name of Stream: TRIBUTARY TO JONES CREEK

Name of Dam: LAKE HENRY DAM

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
K-1	2.13	0.45	1.23	2.61	1.16	N/A	1.71	1	A
M-1	0.30	0.45	1.23	0.89	0.36	N/A	.87	1	A
H-1	3.42	0.45	1.23	4.26	1.67	N/A	2.22	1	A
Total	5.85								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

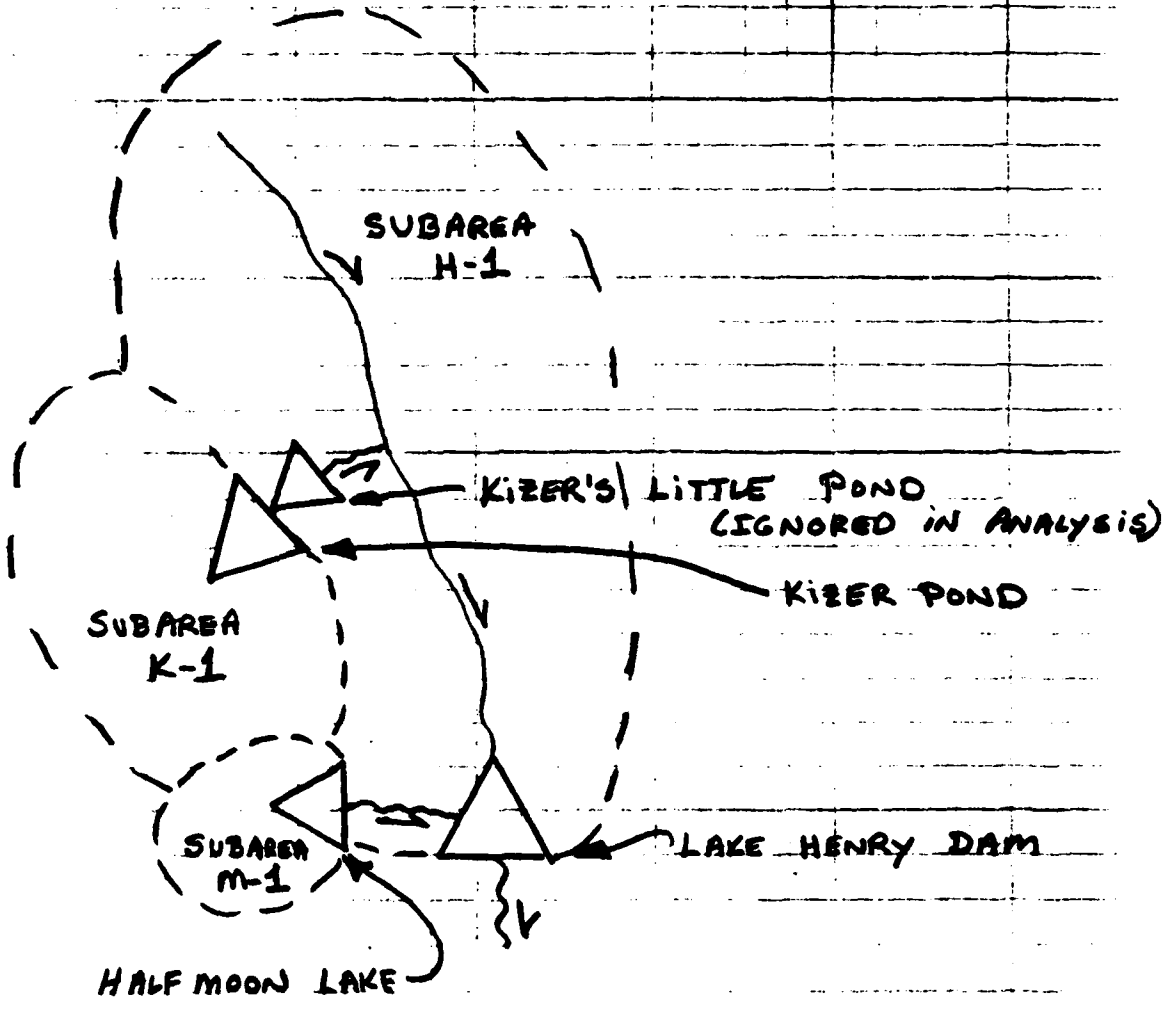
RAINFALL DATA:

PMF Rainfall Index= 22.0 in., 24 hr., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	1
Geographic Adjustment Factor:	N/A	1.0
Revised Index Rainfall:	N/A	22.0

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	111
12 hours	123
24 hours	138
48 hours	142
72 hours	—
96 hours	—



SKETCH
OF
SYSTEM

Data for Dam at Outlet of Subarea K-1 (See sketch on Sheet D-4)

Name of Dam: Kizer Pond

STORAGE DATA:

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
1542.9	=ELEVO*	0		0	0		STREAMBED AT TOE
1546.9	~~=ELEV1~~	101	=A1		136	=S1	SPILLWAY CREST
1547.0	=ELEV1	106			145		WATER SURFACE
1548.8		120			350		TOP OF DAM
1560.0	**	226					

* ~~ELEVO = ELEV1 - (3S1/A1)~~ $S_1 = A_1 (ELEV1 - ELEVO)/3$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 8 percent of subarea watershed.

BREACH DATA:

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: Silty Sand

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) 3 fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = 0.4 ft., C = 3.1 Top of Dam El.= 1549.6

HMAX + Top of Dam El. = 1550.0 = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = 60 ft (width of bottom of breach)
Z = 1 (side slopes of breach)
ELBM = 1547.8 * (bottom of breach elevation, minimum of zero storage elevation)
WSEL = 1546.9 (normal pool elevation)
T FAIL= 6 mins = 0.1 hrs (time for breach to develop)

* NEAR RIGHT ABUTMENT, TOP OF ROAD ELEV.

Data for Dam at Outlet of Subarea K-1

Name of Dam: KIZER POND

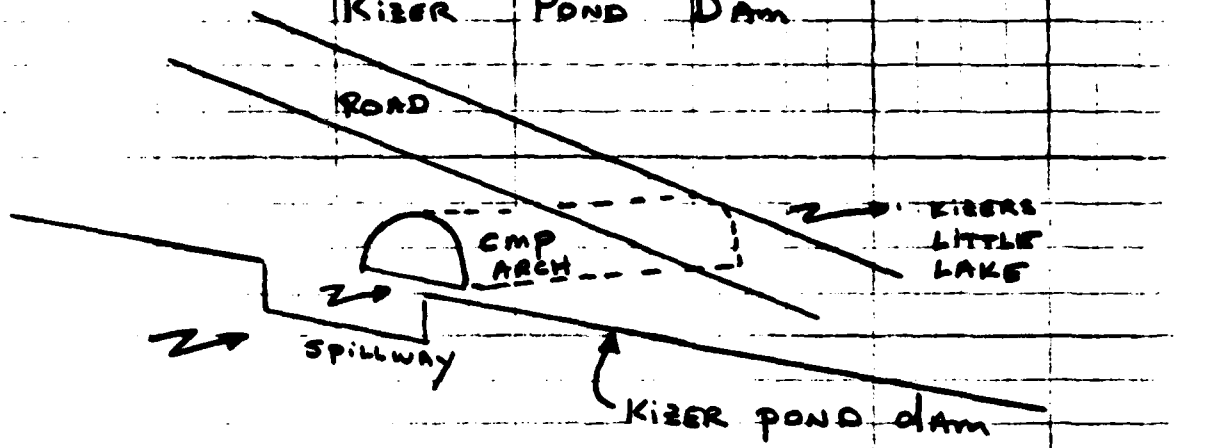
SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	SEE	N/A
Spillway Crest Elevation	FOLLOWING	
Spillway Head Available (ft)	SHEETS	
Type Spillway		
"C" Value - Spillway		
Crest Length - Spillway (ft)		
Spillway Peak Discharge (cfs)		
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: FROM FOLLOWING SHEETS

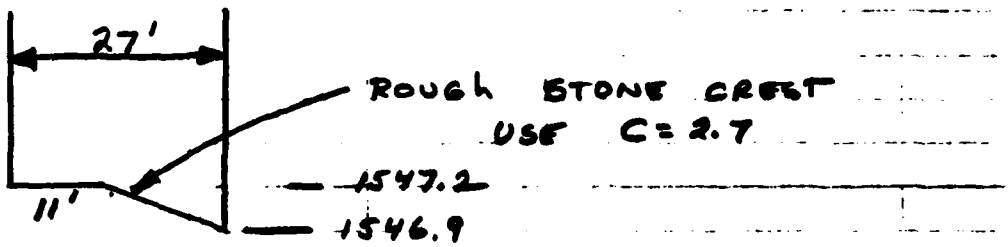
Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1546.9		N/A	0
1547.3			5
1547.9			60
1548.7			174
1549.3			267
1550.0			403
1551.4			724
1552.7			1,067
1554.1			1,491
		N/A	

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	NOT PERTINENT TO		
Invert of Inlet	THIS REPORT		
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction $=29.1 N^2 L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

KIZER POND DAM



SPILLWAY:



$$Q = \frac{2.7}{3.1}\sqrt{\frac{A^3}{T}}$$ (ADJUSTED CRITICAL depth)

Q = FLOW IN CFS A = FLOW AREA (FT^2)
T = TOPWIDTH (FT) $hv = \frac{Q^2}{2gA^2}$

Pool = depth + hv + INVERT

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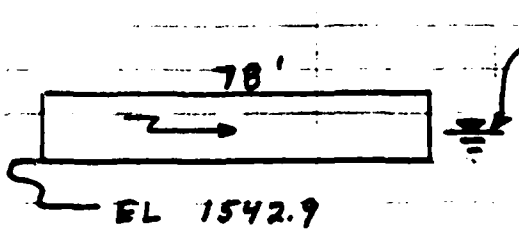
SHEET NO. ____ OF ____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

depth	AREA	Topwidth	Q	hv	pool
0	0	–	0	0	1546.9
0.3	2.4	16	4.6	.1	1547.3
0.8	15.9	27	60	.2	1547.9
1.3	29.4	27	174	.5	1548.7
1.8	42.9	27	267	.6	1549.3
2.3	56.4	27	403	.8	1550.0
3.3	83.4	27	724	1.2	1551.4
4.3	108.0	27	1,067	1.5	1552.7
5.3	135.0	27	1,491	1.9	1554.1

CONDUIT:



TAILWATER CONTROLLED by LITTLE KISZER POND

$A = \frac{\pi ab}{4} = 93.5\square'$

$P = \text{Circum} = 14 + \pi \frac{(a+2b)}{4}$

$= 38.3'$

$R = \frac{A}{P} = 2.44$

PRESSURE FLOW

$K_{FRICTION} = \frac{29.1 n^2 L}{R^{4/3}}$, $n = .024$ (cmp) $K_e = .40$

$K_{ENTR+EXIT} = 0.5 + 1.0 = 1.5$

$\Sigma K = 1.9$

$Q = A\sqrt{\frac{2gH}{\Sigma K}}$ H = HEADWATER – TAILWATER

ASSUME TAILWATER OF 2'
i.e. TAILWATER = EL 1544.9

5018

HEADWATER	Q	
1549.0	1,102	RESULTS INDICATE THAT CONDUIT DOES NOT CONTROL BELOW EL 1554.0
1550.0	1,228	
1551.0	1,344	
1552.0	1,450	
1553.0	1,549	
1554.0	1,642	

However, some of the flow over the top of the dam could also enter the conduit. This, as well as the effects of the tailwater at Little Kiszer Lake, have been ignored

Data for Dam at Outlet of Subarea M-1 (See sketch on Sheet D-4)

Name of Dam: HALF MOON LAKE

STORAGE DATA:

Elevation	Area (acres)	Storage million gals	Storage acre-ft	Remarks
1525.0 =ELEVO*	0	0	0	STREAMbed AT TOE
1535.6 =ELEV1	22 =A1		73 =S1	
1536.2	23		102	TOP OF dam
1540.0	27			
1560.0 **	45			

* ~~ELEVO - ELEV1 (3S1/A1)~~ $S_1 = A_1 (ELEV1 - ELEVO)/3$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 11 percent of subarea watershed.

BREACH DATA: Not Used

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL = _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea M-1

Name of Dam: HALF MOON LAKE

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	SEE APPENDIX B	N/A
Spillway Crest Elevation		
Spillway Head Available (ft)		
Type Spillway	COMPLETELY BLOCKED	
"C" Value - Spillway		
Crest Length - Spillway (ft)		
Spillway Peak Discharge (cfs)		
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: NOT USED

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	NOT PERTINENT TO THIS REPORT		
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1N^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5}$ = C			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea H-1 (See sketch on Sheet D-4)

Name of Dam: LAKE HENRY DAM

STORAGE DATA:

Elevation	Area (acres)	Storage million gals	Storage acre-ft	Remarks
1461.7 =ELEVO*	0	0	0	
1479.0 =ELEV1†	256 =A1	482	1,479 =S1	RECORD DATA
1480.0	319		1,766	USGS LAKE AREA
1481.9	337		2,389	
1500 **	535			

* ELEVO = ELEV1 - $(3S_1/A_1)$ (FROM ABOVE, APPROXIMATELY 262 A.F. CONTAINED IN 8.1 ACRE NATURAL LAKE)

** Planimetered contour at least 10 feet above top of dam

† APPROX. INVERT STOPLOG

Reservoir Area at Normal Pool is 15 percent of subarea watershed.

BREACH DATA:

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: DRY STONE MASONRY

Maximum Permissible Velocity (Plate ~~28~~ 29, EM 1110-2-1601) 6.5 fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = 2.0 ft., C = 3.1 Top of Dam El.= 1481.9

HMAX + Top of Dam El. = 1483.9 = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = 50 ft (width of bottom of breach)
Z = 0 (side slopes of breach)
ELBM = 1471.4 (bottom of breach elevation, minimum of zero storage elevation)
WSEL = 1480.0 (normal pool elevation)
T FAIL= 6 mins = 0.1 hrs (time for breach to develop)

Data for Dam at Outlet of Subarea H-1

Name of Dam: LAKE HENRY DAM

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	SEE	INSUFFICIENT
Spillway Crest Elevation	BELOW	DATA
Spillway Head Available (ft)		TO
Type Spillway		CALCULATE
"C" Value - Spillway		
Crest Length - Spillway (ft)		
Spillway Peak Discharge (cfs)		
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: SEE NEXT SHEET

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1480.0	0	0	0
1480.1	4	0	4
1480.7	49	44	93
1481.3	162	125	287
1481.9	342	230	572
1482.4	523	332	855
1483.9	1,195	704	1,899
1486.4	2,982	1,503	4,485
1492.5	10,785	4,150	14,935

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	NONE	AT SITE	
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1_N{}^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5}$ = C			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

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COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

LAKE HENRY DAM
MAIN SPILLWAY RATING

USING $Q = \frac{2.7}{3.1}\sqrt{\frac{A^3 g}{T}}$ (CFS)

A = FLOW AREA (FT^2) T = TOPWIDTH

$hv = \frac{Q^2}{2gA^2}$ POOL = INVERT + depth + hv

ACTUAL CALCULATION by desk CALCULATOR

depth	Q	POOL
0	0	1480.0
0.5	49	1480.7
1.0	162	1481.3
1.5	342	1481.9
1.9	523	1482.4
3.0	1,195	1483.9
5.0	2,982	1486.4
10.0	10,785	1492.5
0.1	4	1480.1

AUXILIARY SPILLWAY:

$Q = CLH^{3/2}$ $C = 2.7$

$L = 35.2'$ $H = POOL - 1480.1$

POOL	Q
1480.1	0
1480.7	44
1481.3	125
1481.9	230
1482.4	332
1483.9	704
1486.4	1,503
1492.5	4,150

SELECTED COMPUTER OUTPUT INDEX

(1) PLAN 1 - NO DAM FAILURES
PLAN 2 - ONLY LAKE HENRY DAM FAILS
PLAN 3 - BOTH LAKE HENRY DAM AND KIZER POND DAM FAIL.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1                        NATIONAL DAM INSPECTION PROGRAM
    2                A2                        TRIBUTARY TO JONES CREEK
    3                A3                            LAKE HENRY DAM
    4                B    300       0       15       0       0       0       0       0      -4       0
    5                B1     5
    6                J      1       9       1
    7                J1     1      .5      .4       .3      .25     .2      .15     .1     .05
    8                K      0       1                                               1
    9                K1       RUNOFF INTO KIZER POND (SUBAREA K-1)
   10                M      1       1     2.13               5.85                                 1
   11                P                    22      111     123     133     142
   12                T                                                           1.0     .05             .08
   13                W    1.71    0.45
   14                X    -1.5   -0.05     2.0
   15                K      1       1                                               1
   16                K1       ROUTE THROUGH KIZER POND DAM
   17                Y                                       1
   18                Y1     1                                                    -1546.9    -1
   19                Y61546.9  1547.3  1547.9  1548.7  1549.3  1550.0  1551.4  1552.7  1554.1
   20                Y5     0       5      60     174     267     403     724    1067    1491
   21                SA     0     106     226
   22                SE1542.9    1547    1560
   23                SS1546.9
   24                SD1549.6
   25                SL     0      24     140     178     230     280
   26                SV1549.6  1549.7  1550.0  1550.8  1552.5  1554.3
   27                K      1      1A                                               1
   28                K1       ROUTE TO LAKE HENRY
   29                Y                                       1
   30                Y1     1                                                      -1
   31                Y6   .09     .07     .09  1489.6    1520    3750   .0053
   32                Y7     0    1580     450    1520     680    1500    1000  1489.6    1010  1489.6
   33                Y7  1180    1500    1300    1520    1950    1560
   34                K      0       2                                               1
   35                K1       RUNOFF INTO HALF MOON LAKE (SUBAREA M-1)
   36                M      1       1      .30               5.85                                 1
   37                P                    22      111     123     133     142
   38                T                                                           1.0     .05             .11
   39                W    .87     .45
   40                X    -1.5   -0.05     2.0
   41                K      1       2                                               1
   42                K1       ROUTE THROUGH HALF MOON LAKE
   43                Y                                       1
   44                Y1     1                                                    -1535
   45                SA     0      22      27      45
   46                SE   1525    1535    1540    1560
   47                SS   1535     .01     .01     1.5
   48                SD1536.2
   49                SL   180     310     405     445     485     600     600
   50                SV1536.2  1536.3  1536.7  1536.8  1537.0  1537.1    1540
```

```
51              K      0       3                                                      1
52              K1      UNCONTROLLED RUNOFF INTO LAKE HENRY(SUBAREA H-1)
53              H      1       1     3.42              5.85                                          1
54              P              22     111      123      133      142
55              T                                                          1.0      .05              .15
56              W   2.22     .45
57              X   -1.5   -0.05     2.0
58              K      3       3                                                      1
59              K1      COMBINE RUNOFF INTO LAKE HENRY
60              K      1       3                                                      1
61              K1      ROUTE THROUGH LAKE HENRY DAM
62              Y                                      1
63              Y1     1                                                    -1480      -1
64              Y1480.0  1480.1  1480.7  1481.3  1481.9  1482.4  1483.9  1486.4  1492.5
65              Y5     0       4      93     287      572      855     1999     4485    14935
66              SA     0     256     319     535
67              SE1461.7    1479    1480    1500
68              SS  1480
69              SD1481.9
70              SL     0       1      20      87      111      130      146      146
71              SV1481.9  1482.0  1482.1  1482.2  1482.3  1482.5  1483.0     1500
72              K     99
```

D-17

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50	RATIO 3 .40	RATIO 4 .30	RATIO 5 .25	RATIO 6 .20	RATIO 7 .15	RATIO 8 .10	RATIO 9 .05
HYDROGRAPH AT	1	2.13	1	4589.	2295.	1836.	1377.	1147.	918.	688.	459.	229.
		(5.52)		(129.96)(	64.98)(	51.98)(	38.99)(	32.49)(	25.99)(	19.49)(	13.00)(	6.50)
ROUTED TO	1	2.13	1	3962.	1665.	1192.	720.	496.	332.	231.	139.	50.
		(5.52)		(112.20)(	47.16)(	33.76)(	20.40)(	14.00)(	9.40)(	6.55)(	3.95)(	1.41)
ROUTED TO	1A	2.13	1	3943.	1648.	1178.	716.	489.	331.	230.	139.	49.
		(5.52)		(111.66)(	46.66)(	33.35)(	20.23)(	13.84)(	9.36)(	6.52)(	3.93)(	1.40)
HYDROGRAPH AT	2	.30	1	929.	465.	372.	279.	232.	186.	139.	93.	46.
		(.78)		(26.32)(	13.16)(	10.53)(	7.909)(	6.583)(	5.26)(	3.95)(	2.63)(	1.32)
ROUTED TO	2	.30	1	907.	446.	354.	261.	213.	157.	97.	31.	0.
		(.78)		(25.68)(	12.64)(	10.03)(	7.38)(	6.02)(	4.45)(	2.75)(	.86)(	.00)
HYDROGRAPH AT	3	3.42	1	6381.	3190.	2552.	1914.	1595.	1276.	957.	638.	319.
		(8.86)		(180.69)(	90.34)(	72.28)(	54.21)(	45.17)(	36.14)(	27.10)(	18.07)(	9.03)
3 COMBINED	3	5.85	1	10635.	4734.	3542.	2417.	1998.	1584.	1158.	701.	339.
		(15.15)		(301.15)(	134.06)(	100.31)(	68.44)(	56.59)(	44.85)(	32.78)(	19.96)(	9.58)
ROUTED TO	3	5.85	1	8182.	3151.	2200.	1327.	925.	636.	419.	223.	73.
		(15.15)		(231.68)(	89.22)(	62.29)(	37.59)(	26.19)(	18.01)(	11.87)(	6.32)(	2.07)

SUMMARY OF DAM SAFETY ANALYSIS

KIZER POND DAM

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1546.90	1546.90	1549.60
STORAGE	135.	135.	447.
OUTFLOW	0.	0.	325.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1552.80	3.20	894.	3962.	16.25	42.75	0.00
.50	1551.36	1.76	682.	1665.	12.25	43.50	0.00
.40	1550.95	1.35	625.	1192.	11.00	43.75	0.00
.30	1550.43	.83	555.	720.	9.00	44.50	0.00
.25	1550.10	.50	511.	496.	7.25	45.00	0.00
.20	1549.83	.03	451.	332.	2.00	45.50	0.00
.15	1549.07	0.00	381.	231.	0.00	45.75	0.00
.10	1548.46	0.00	307.	139.	0.00	46.00	0.00
.05	1547.79	0.00	231.	50.	0.00	47.25	0.00

PLAN 1 STATION 1A

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3943.	1496.2	43.00
.50	1648.	1494.3	43.75
.40	1178.	1493.6	44.00
.30	716.	1493.0	44.75
.25	489.	1492.4	45.50
.20	331.	1491.9	46.00
.15	230.	1491.6	46.25
.10	139.	1491.3	46.50
.05	49.	1490.3	48.00

SUMMARY OF DAM SAFETY ANALYSIS

HALF MOON LAKE DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1535.00	1535.00	1536.20
STORAGE	73.	73.	100.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1537.07	.87	121.	907.	41.00	40.75	0.00
.50	1536.79	.59	114.	466.	37.50	40.75	0.00
.40	1536.71	.51	112.	354.	37.00	40.75	0.00
.30	1536.62	.42	110.	261.	36.25	40.75	0.00
.25	1536.57	.37	109.	213.	35.75	41.00	0.00
.20	1536.51	.31	108.	157.	35.00	41.25	0.00
.15	1536.43	.23	106.	97.	34.50	42.00	0.00
.10	1536.32	.12	103.	31.	33.00	43.50	0.00
.05	1535.92	0.00	92.	0.	0.00	75.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS

LAKE HENRY DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1480.00	1480.00	1481.90
STORAGE	1763.	1763.	2886.
OUTFLOW	0.	0.	572.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1486.35	4.45	3985.	8182.	23.50	44.25	0.00
.50	1484.05	2.15	3134.	3151.	19.00	45.25	0.00
.40	1483.46	1.56	2926.	2200.	17.50	45.75	0.00
.30	1482.80	.90	2693.	1327.	14.75	46.75	0.00
.25	1482.43	.53	2566.	925.	12.25	47.50	0.00
.20	1482.01	.11	2425.	636.	6.25	48.50	0.00
.15	1481.58	0.00	2278.	419.	0.00	49.00	0.00
.10	1481.10	0.00	2121.	223.	0.00	50.25	0.00
.05	1480.57	0.00	1945.	73.	0.00	52.25	0.00

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1              A1                    NATIONAL DAM INSPECTION PROGRAM
    2              A2                    TRIBUTARY TO JONES CREEK
    3              A3                        LAKE HENRY DAM
    4              R    300       0       6       0       0       0       0       0      -4       0
    5              B1     5
    6              J      3       2       1
    7              J1    .5      .25
    8              K      0       1                                               1
    9              K1       RUNOFF INTO KIZER POND (SUBAREA K-1)
   10              M      1       1    2.13               5.85                                    1
   11              P                    22     111     123     133
   12              Y                                                           1.0     .05             .08
   13              W   1.71    0.45
   14              X   -1.5   -0.05    2.0
   15              K      1       1                                               1
   16              K1       ROUTE THROUGH KIZER POND DAM
   17              Y                                    1       1
   18              Y1     1                                                 -1546.9    -1
   19              Y6  1546.9  1547.3  1547.9  1548.7  1549.3  1550.0  1551.4  1552.7  1554.1
   20              YS     0       5      60     174     267     403     724    1067    1491
   21              SA     0     106     226
   22              SE  1542.9    1547    1560
   23              SS  1546.9
   24              SD  1549.6
   25              SL     0      24     140     178     230     280
   26              SV  1549.6  1549.7  1550.0  1550.5  1552.5  1554.3
   27              SR    60       1  1547.8      .1  1546.9  1560.0
   28              SR    60       1  1547.8      .1  1546.9  1560.0
   29              SB    60       1  1547.8      .1  1546.9  1550.0
   30              K      1      1A                                               1
   31              K1       ROUTE TO LAKE HENRY
   32              Y                                    1       1
   33              Y1     1                                                    -1
   34              Y6   .09     .07     .09  1489.6    1520    3750   .0053
   35              Y7     0    1580     450    1520     680    1500    1000  1489.6    1010  1489.6
   36              Y7  1180    1500    1300    1520    1950    1560
   37              K      0       2                                               1
   38              K1       RUNOFF INTO HALF MOON LAKE (SUBAREA H-1)
   39              M      1       1    .30               5.85                                    1
   40              P                    22     111     123     133
   41              T                                                           1.0     .05             .11
   42              W    .87     .45
   43              X   -1.5   -0.05    2.0
   44              K      1       2                                               1
   45              K1       ROUTE THROUGH HALF MOON LAKE
   46              Y                                    1       1
   47              Y1     1                                                 -1535
   48              SA     0      22      27      45
   49              SE  1525    1535    1540    1560
   50              SS  1535     .01     .01     1.5
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91          SD1536.2
92          SL   180      310      405      445      485      600      600
93          SV1536.2  1536.3   1536.7   1536.8   1537.0   1537.1   1540
94          SR    60        1   1525.0       .1     1535   1560.0
95          SR    60        1   1525.0       .1     1535   1560.0
96          SR    60        1   1525.0       .1     1535   1560.0
97          K      0        3                                      1
98          K1      UNCONTROLLED RUNOFF INTO LAKE HENRY(SUBAREA H-1)
99          H      1        1     3.62              5.85                                    1
100         P                22      111      123      133
101         T                                                  1.0      .05                .15
102         W    2.22      .45
103         X   -1.5    -0.05      2.0
104         K      3        3                                      1
105         K1      COMBINE RUNOFF INTO LAKE HENRY
106         K      1        3                                      1
107         K1      ROUTE THROUGH LAKE HENRY DAM
108         Y                                1        1
109         Y1     1                                          -1480       -1
110         Y4 1480.0   1480.1   1480.7   1481.3   1491.9   1482.4   1493.9   1486.4   1492.5
111         Y5     0        4       93      287      572      855     1909     4485     14035
112         SA     0      256      319      535
113         SS 1461.7     1479     1480     1500
114         SS  1480
115         SD1481.9
116         SL     0        1       20       87      111      130      146      146
117         SV1481.9   1482.0   1482.1   1482.2   1482.3   1482.5   1493.0     1500
118         SR    50        0   1471.4       .1     1480     1500
119         SR    50        0   1471.4       .1     1480   1483.9
120         SR    50        0   1471.4       .1     1480   1483.9
121         K      1        4                                      1
122         K1      SECTION NEAR BREACHED DAM
123         Y                                1        1
124         Y1     1                                            -1
125         Y6   .09      .07      .09     1390     1420     4000      .04
126         Y7     0     1500      400     1420      500     1400      560     1390      570     1390
127         Y7   600     1400      600     1420      900     1440
128         K      1        5                                      1
129         K1      SECTION AT UPSTREAM END OF SWAMP
130         Y                                1        1
131         Y1     1                                            -1
132         Y6   .09      .06      .09     1356     1400     4000    .0019
133         Y7     0     1400      150     1380      600     1360      650     1356      750     1356
134         Y7   780     1360     1610     1390     1900     1400
135         K      1        6                                      1
136         K1      SECTION AT DOWNSTREAM END OF SWAMP
137         Y                                1        1
138         Y1     1                                            -1
139         Y6   .09      .06      .09     1341     1380     9200    .0013
140         Y7     0     1400      100     1380      210     1360      580     1341      590     1341
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101
102

77 1820 1360 1910 1380 2050 1400
K 99

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .50	RATIO 2 .25
HYDROGRAPH AT	1	2.13	1	2309.	1154.
	(	5.52)	(	65.38)(	32.69)(
			2	2309.	1154.
			(	65.38)(	32.69)(
			3	2309.	1154.
			(	65.38)(	32.69)(
ROUTED TO	1	2.13	1	1609.	457.
	(	5.52)	(	45.56)(	12.94)(
			2	1609.	457.
			(	45.56)(	12.94)(
			3	1806.	1030.
			(	51.08)(	29.16)(
ROUTED TO	1A	2.13	1	1590.	452.
	(	5.52)	(	45.03)(	12.81)(
			2	1590.	452.
			(	45.03)(	12.81)(
			3	1792.	888.
			(	50.74)(	25.16)(
HYDROGRAPH AT	2	.30	1	471.	235.
	(	.78)	(	13.34)(	6.67)(
			2	471.	235.
			(	13.34)(	6.67)(
			3	471.	235.
			(	13.34)(	6.67)(
ROUTED TO	2	.30	1	449.	204.
	(	.78)	(	12.70)(	5.76)(
			2	449.	204.
			(	12.70)(	5.76)(
			3	449.	204.
			(	12.70)(	5.76)(
HYDROGRAPH AT	3	3.42	1	3189.	1595.
	(	8.86)	(	90.31)(	45.16)(
			2	3189.	1595.
			(	90.31)(	45.16)(
			3	3189.	1595.
			(	90.31)(	45.16)(
3 COMBINED	3	5.85	1	4616.	1968.
	(	15.15)	(	130.72)(	55.73)(
			2	4616.	1968.
			(	130.72)(	55.73)(
			3	5001.	1968.

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				(161.61)(	55.73)(
ROUTED TO	3	5.85	1	2962.	844.
	(	15.15)	(	83.87)(	23.91)(
			2	8686.	844.
			(	245.96)(	23.91)(
			3	8721.	1001.
			(	246.95)(	28.35)(
ROUTED TO	4	5.85	1	2961.	844.
	(	15.15)	(	83.84)(	23.90)(
			2	8408.	844.
			(	238.08)(	23.90)(
			3	8467.	1001.
			(	239.76)(	28.34)(
ROUTED TO	5	5.85	1	2964.	842.
	(	15.15)	(	83.36)(	23.84)(
			2	7392.	842.
			(	209.32)(	23.84)(
			3	7495.	997.
			(	212.23)(	28.23)(
ROUTED TO	6	5.85	1	2803.	811.
	(	15.15)	(	79.36)(	22.97)(
			2	6290.	811.
			(	178.12)(	22.97)(
			3	6401.	948.
			(	181.25)(	26.84)(

SUMMARY OF DAM SAFETY ANALYSIS

KIZER POND DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1546.90	1546.90	1549.60
STORAGE	135.	135.	667.
OUTFLOW	0.	0.	325.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1551.32	1.72	676.	1605.	11.20	19.50	0.00
.25	1550.03	.43	502.	657.	6.60	21.20	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1546.90	1546.90	1549.60
STORAGE	135.	135.	667.
OUTFLOW	0.	0.	325.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1551.32	1.72	676.	1409.	11.20	19.50	0.00
.25	1550.03	.43	502.	657.	6.60	21.20	0.00

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1546.90	1546.90	1549.60
STORAGE	135.	135.	667.
OUTFLOW	0.	0.	325.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1550.79	1.19	603.	1204.	7.20	19.10	17.10
.25	1550.00	.40	498.	1030.	3.00	20.50	20.40

PLAN 1 STATION 1A

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	1590.	1496.3	19.80
.25	652.	1492.3	21.60

PLAN 2 STATION 1A

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	1590.	1496.3	19.80

.25	452.	1492.3	21.60

PLAN 3 STATION 1A

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	1792.	1494.5	19.40
.25	888.	1493.2	21.30

SUMMARY OF DAM SAFETY ANALYSIS

HALF MOON LAKE DAM

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1535.00	1535.00	1536.20
STORAGE	73.	73.	100.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1536.78	.58	114.	449.	15.70	16.70	0.00
.25	1536.57	.37	109.	204.	14.20	17.00	0.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1535.00	1535.00	1536.20
STORAGE	73.	73.	100.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1536.78	.58	114.	449.	15.70	16.70	0.00
.25	1536.57	.37	109.	204.	14.20	17.00	0.00

PLAN 3 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1535.00	1535.00	1536.20
STORAGE	73.	73.	100.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1536.78	.58	114.	449.	15.70	16.70	0.00
.25	1536.57	.37	109.	204.	14.20	17.00	0.00

SUMMARY OF DAM SAFETY ANALYSIS

LAKE HENRY DAM

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1480.00	1480.00	1481.90
STORAGE	1763.	1763.	2386.
OUTFLOW	0.	0.	572.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1483.95	2.05★	3099.	2962.	12.70★	21.50	0.00
.25	1482.33	.43	2533.	844.	9.90	23.60	0.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1480.00	1480.00	1481.90
STORAGE	1763.	1763.	2386.
OUTFLOW	0.	0.	572.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1483.91	2.01	3085.	8686.	5.40	20.90	20.80
.25	1482.33	.43	2533.	844.	9.90	23.60	0.00

PLAN 3 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1480.00	1480.00	1481.90
STORAGE	1763.	1763.	2386.
OUTFLOW	0.	0.	572.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1483.93	2.03	3091.	8721.	5.10	20.30	20.20
.25	1482.50	.60	2592.	1001.	10.10	23.70	0.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	2961.	1396.8	21.60
.25	844.	1393.9	23.70

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	8609.	1400.5	21.10

★ Because of routing increment used, these numbers differ from Multi-Ratio Analysis. The Multi-Ratio figures are more correct.

.25	846.	1393.9	22.70

PLAN 3 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	9467.	1400.5	20.50
.25	1001.	1394.2	23.90

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	2944.	1361.8	21.90
.25	842.	1359.0	24.10

PLAN 2 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	7392.	1365.1	21.70
.25	842.	1359.0	24.10

PLAN 3 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	7495.	1365.1	21.10
.25	997.	1359.3	24.20

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	2803.	1346.4	23.00
.25	811.	1344.2	25.60

PLAN 2 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.50	6290.	1348.4	22.80
.25	811.	1344.2	25.60

PLAN 3 STATION 6

	MAXIMUM	MAXIMUM	TIME

RATIO	FLOW,CFS	STAGE,FT	HOURS
.50	6401.	1368.5	22.30
.25	968.	1364.4	25.70

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
SHEET NO. _____ OF _____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

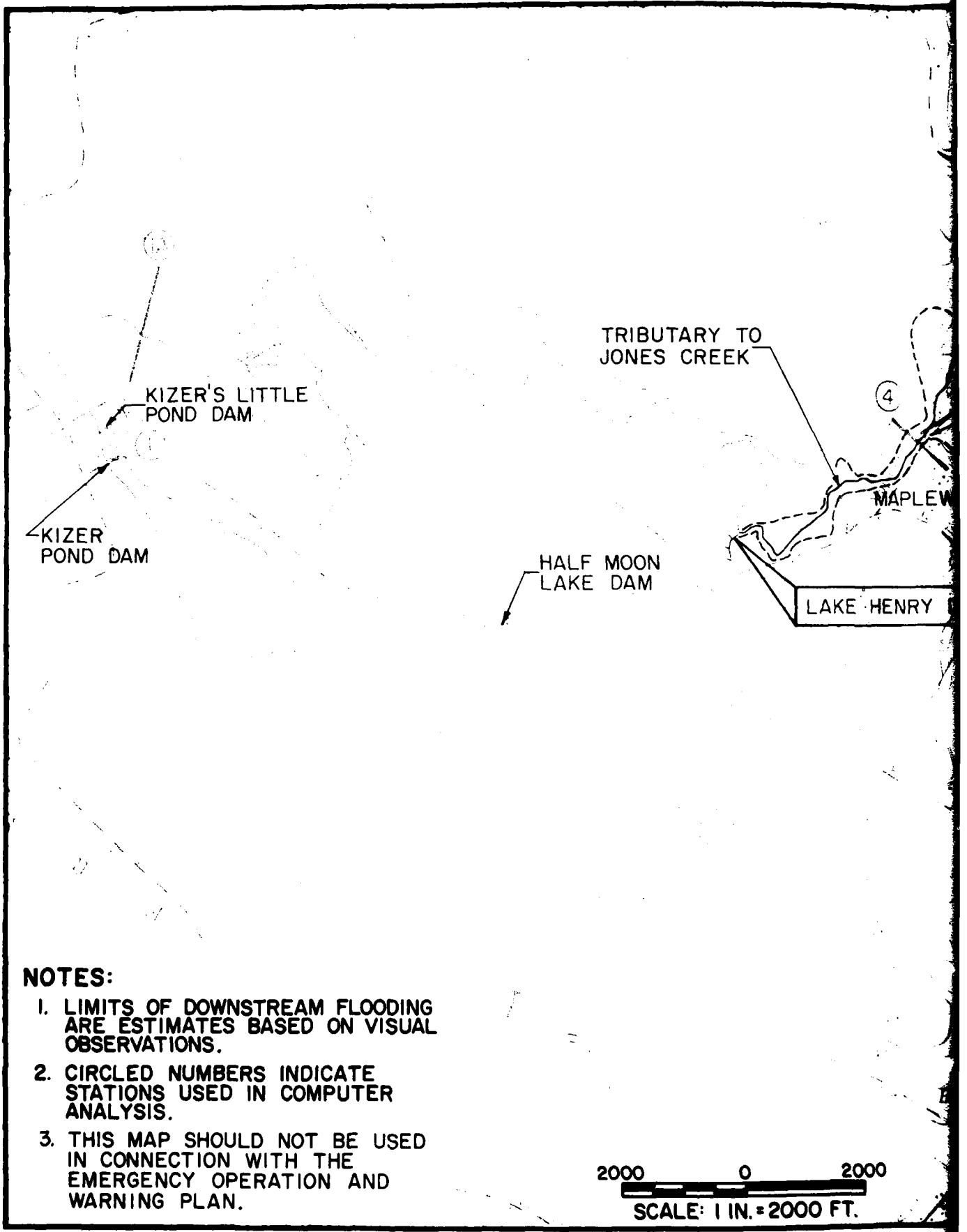
Summary of Pertinent Results

PMF Rainfall = 24.99"

	PMF	½ PMF
Runoff (inches)	22.89	11.45
Peak Inflow to Lake Henry (cfs)	10,635	4,734
*Depth of Overtopping (ft)	2.15	4.45
*Duration of Overtopping (hr)	19.00	23.50

* At Lake Henry

Breach Analysis:	½ PMF No Dam Failure	Lake Henry Dam Failure
Outflow from Lake Henry (cfs)	2,962	8,686
Water Surface Elevation Δ= Difference		
Station 4	1396.8	1400.5
Δ=	3.7'	
Station 5	1361.8	1365.1
Δ=	3.3'	
Station 6	1346.4	1348.4
Δ=	2.0'	

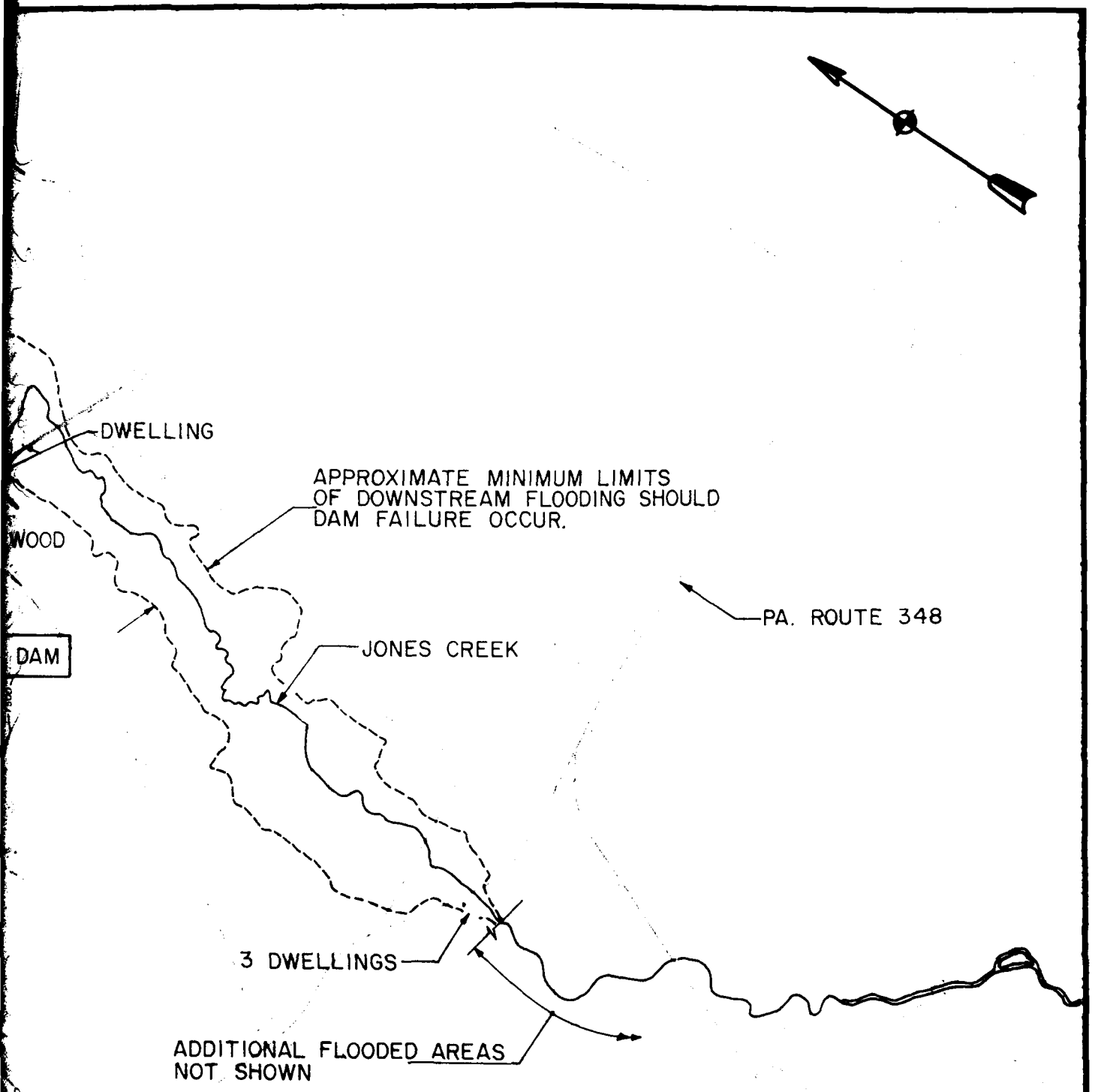


NOTES:

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.

2000 0 2000

SCALE: 1 IN. = 2000 FT.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

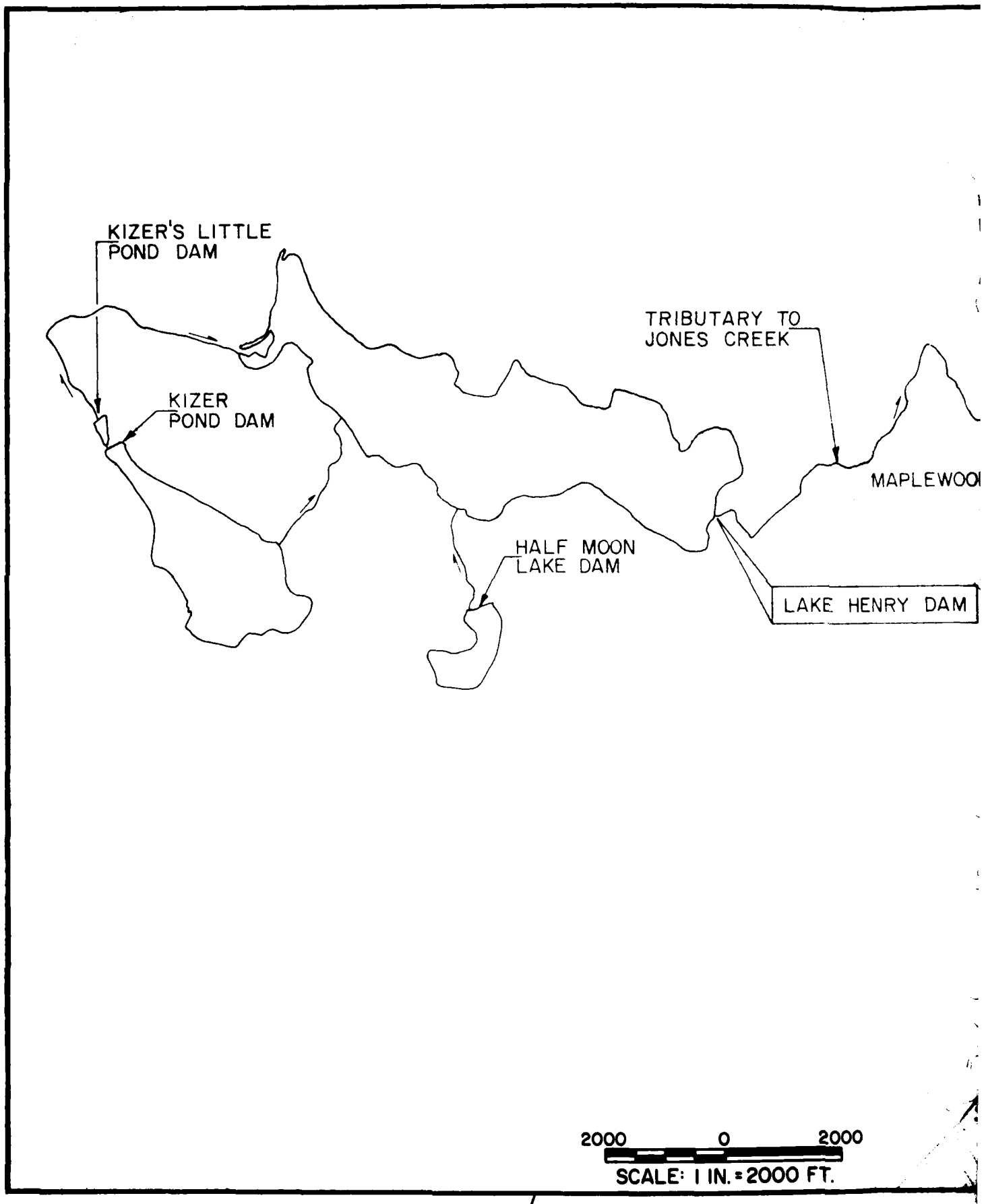
JANET RODGERS AND HELEN STONER

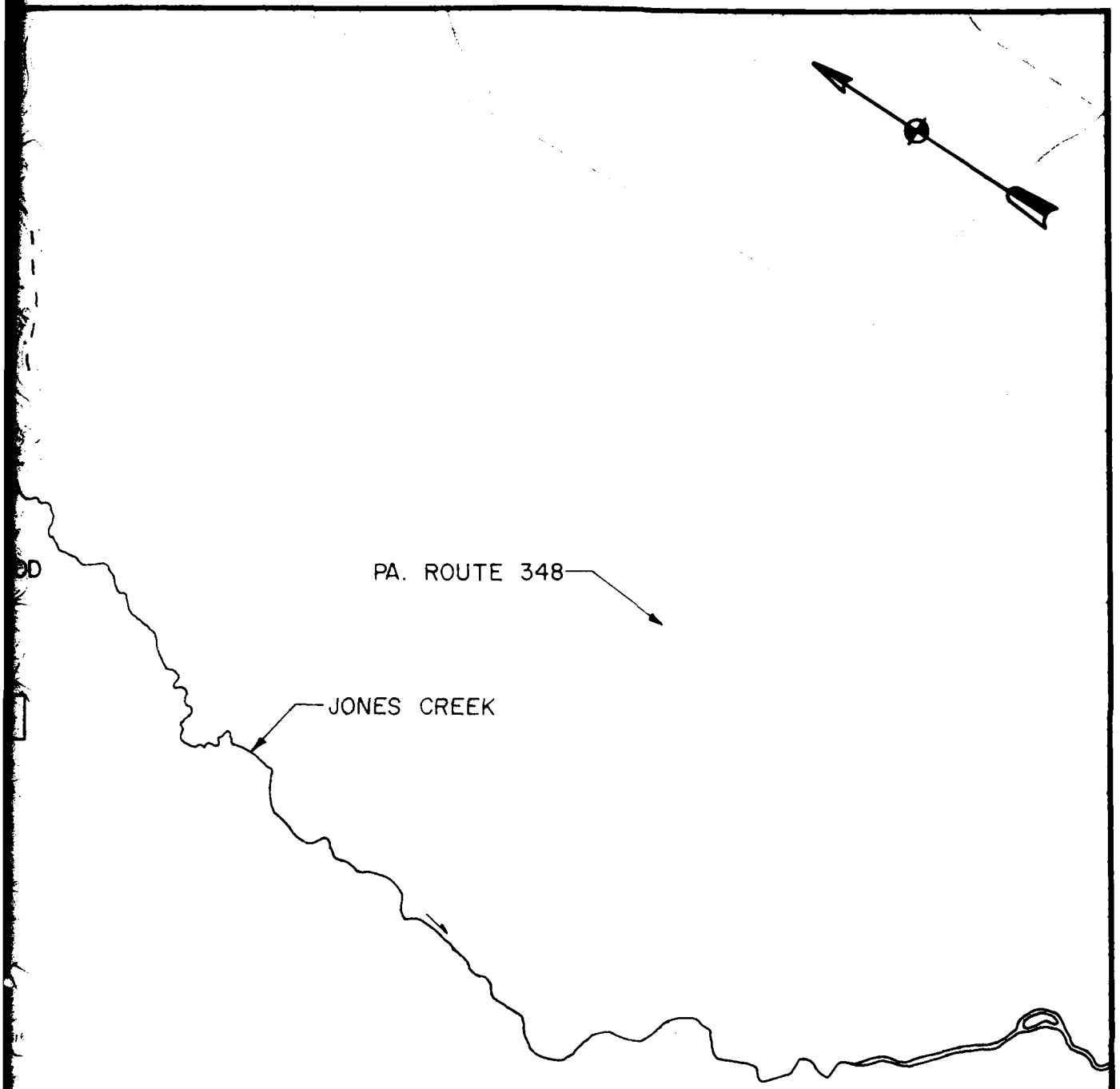
DOWNSTREAM DEVELOPMENT MAP

JULY 1980 EXHIBIT D-1

APPENDIX E

PLATES


KIZER'S LITTLE
POND DAM
KIZER
POND DAM
TRIBUTARY TO
JONES CREEK
MAPLEWOOI
HALF MOON
LAKE DAM
LAKE HENRY DAM
2000
0
2000
SCALE: 1 IN. = 2000 FT.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

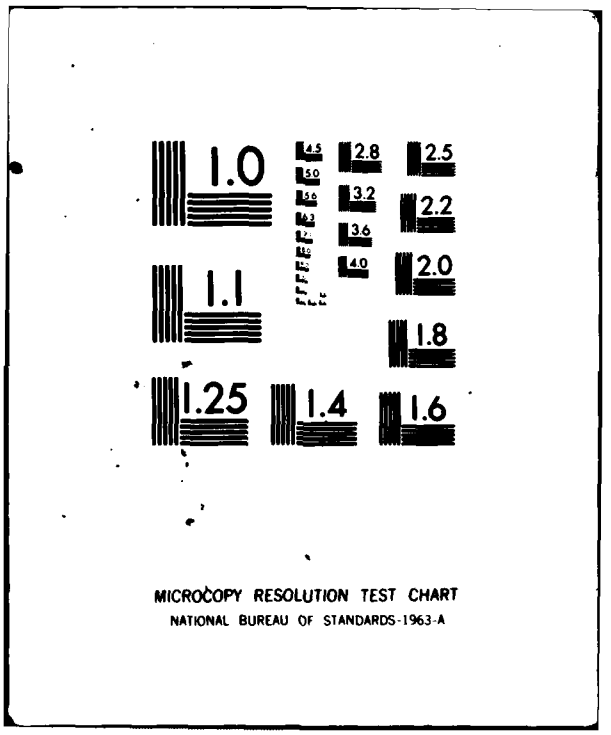
LAKE HENRY DAM

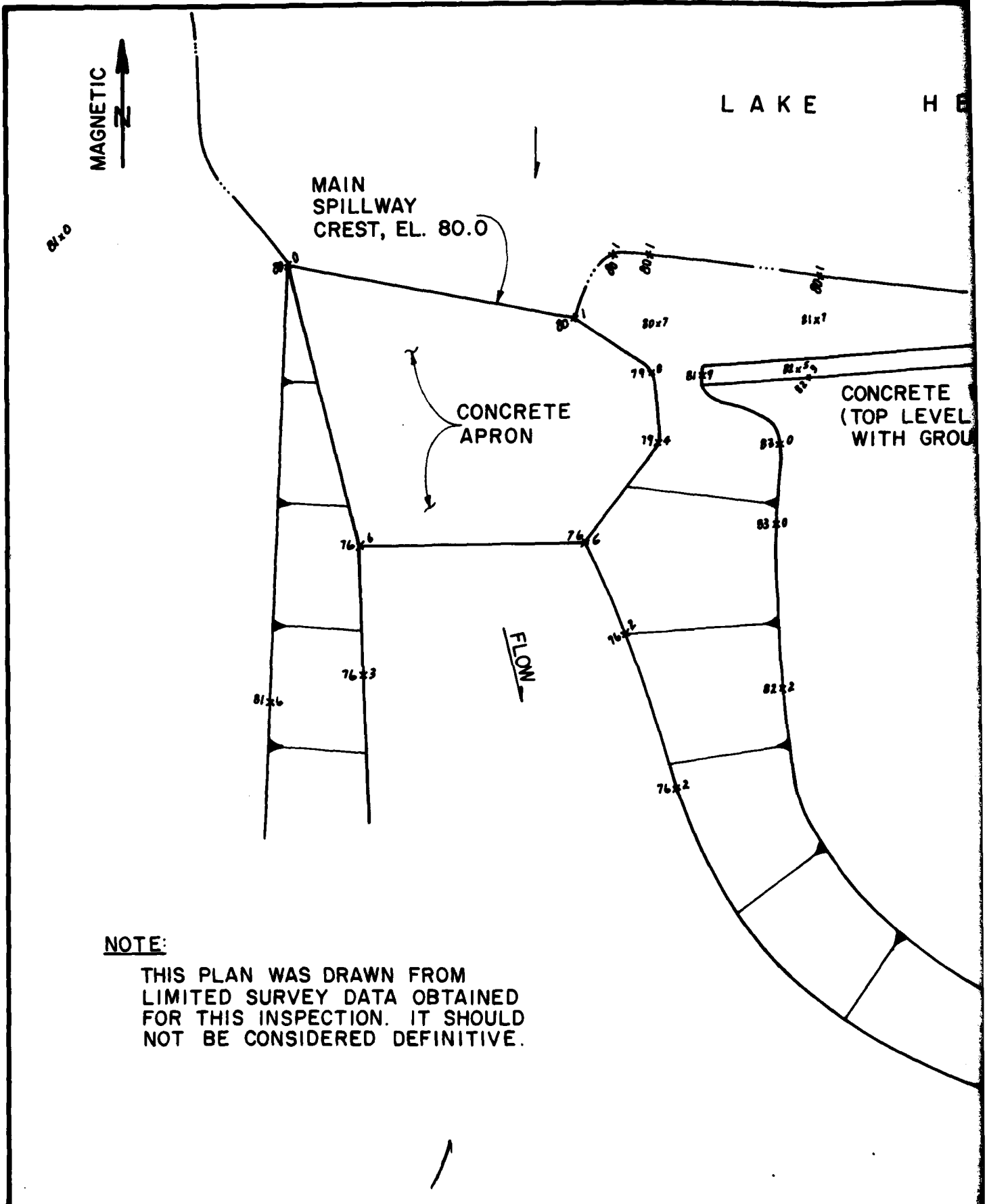
JANET RODGERS AND HELEN STONER

LOCATION MAP

JULY 1980 PLATE E-1

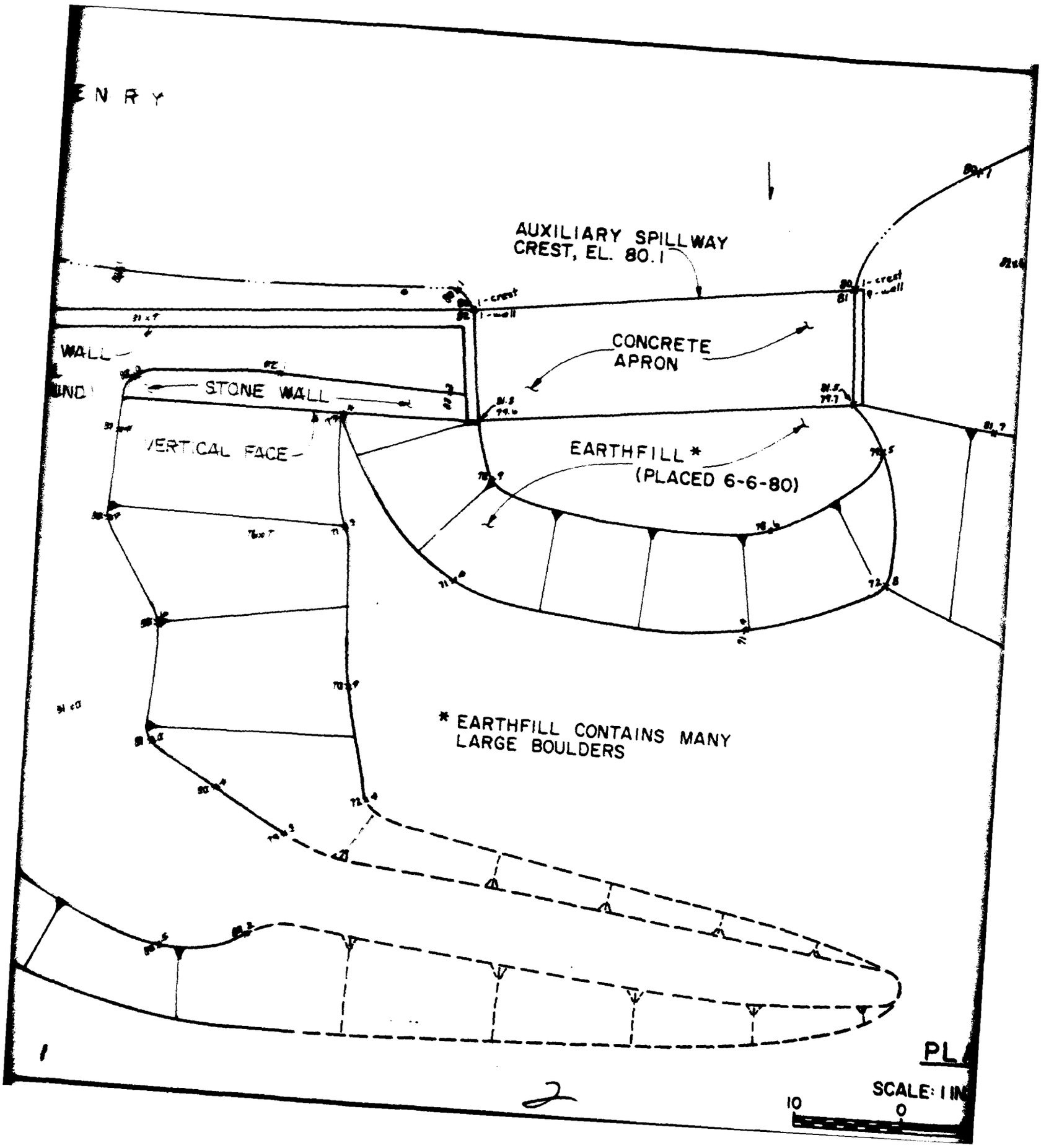
AD-A091 446 GANNETT FLEMING CORDDRY AND CARPENTER INC HARRISBURG PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. LAKE HENRY DAM (NDI ID NUMBER --ETC(U)
JUL 80 F FUTCHKO DACW31-80-C-0017
UNCLASSIFIED NL

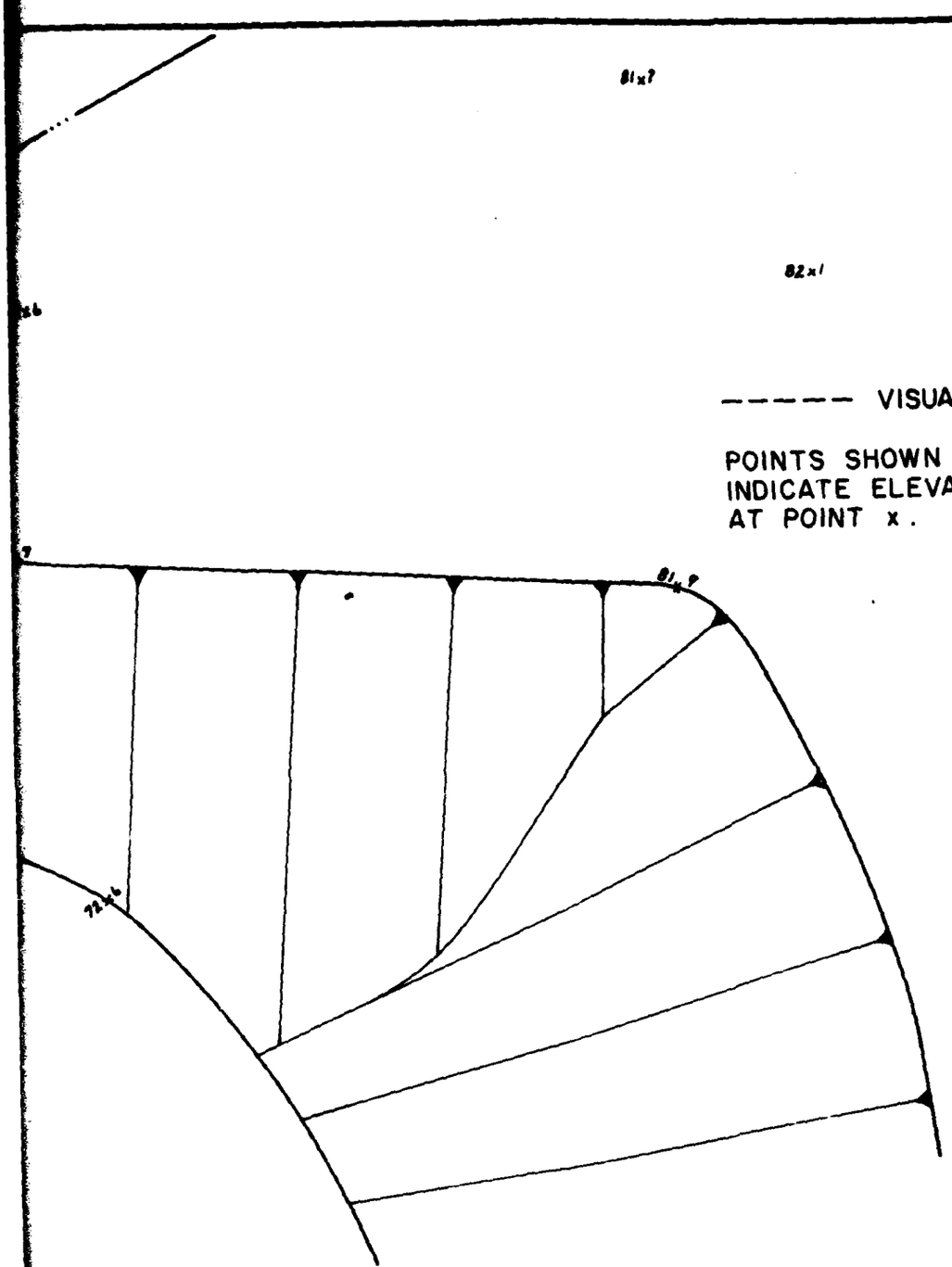

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



NOTE:

THIS PLAN WAS DRAWN FROM LIMITED SURVEY DATA OBTAINED FOR THIS INSPECTION. IT SHOULD NOT BE CONSIDERED DEFINITIVE.


AUXILIARY SPILLWAY
CREST, EL. 80.1
CONCRETE
APRON
STONE WALL
VERTICAL FACE
EARTHFILL *
(PLACED 6-6-80)
* EARTHFILL CONTAINS MANY
LARGE BOULDERS
SCALE: 1 IN
10
0



------ VISUAL ESTIMATE

POINTS SHOWN AS 78x6 e.g.
INDICATE ELEVATION 1478.6
AT POINT x .

AN

1. = 10 FT.

10 20

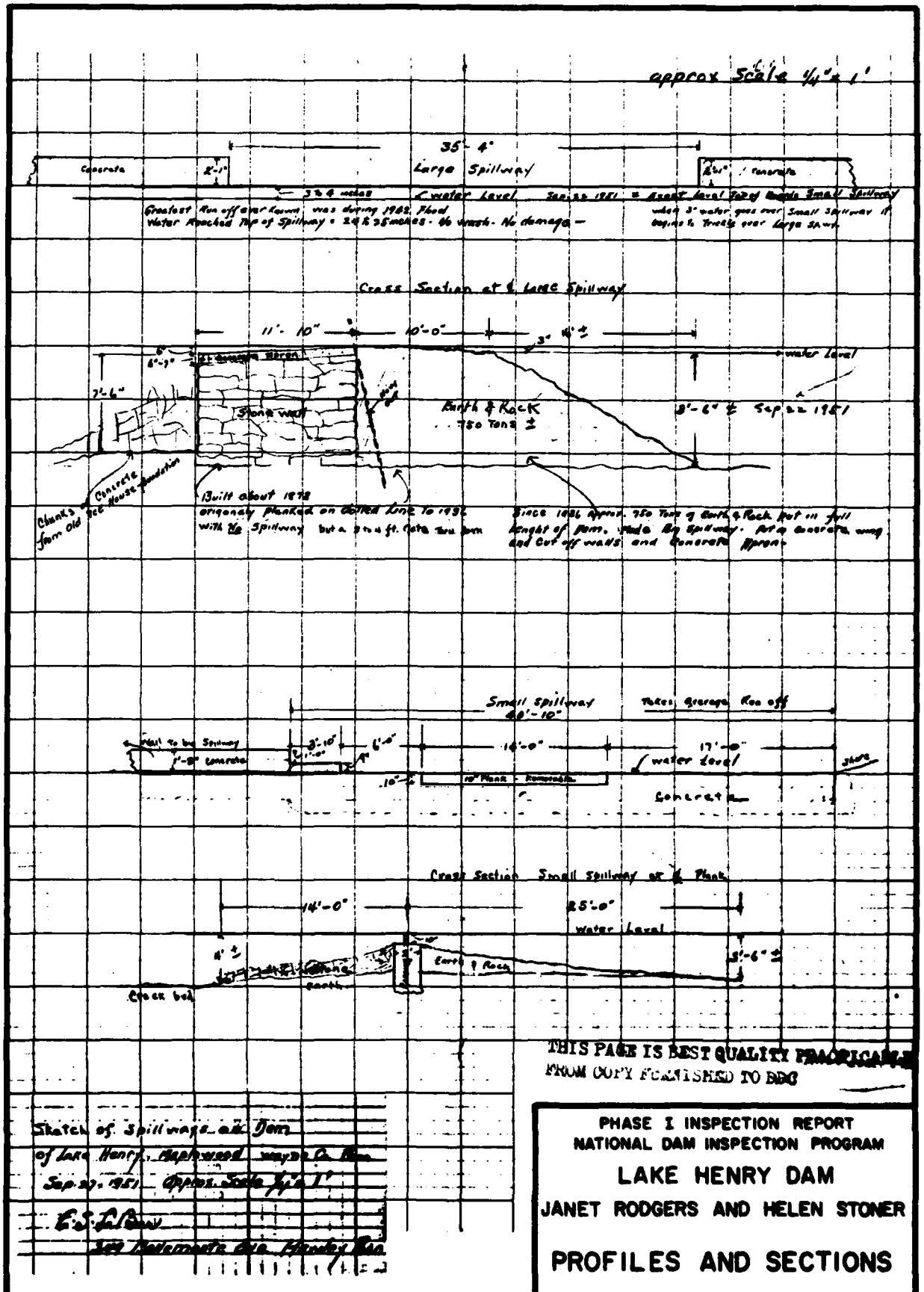
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

JANET RODGERS AND HELEN STONER

PLAN

JULY 1980 PLATE E-2



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FROM COPY FURNISHED TO DDC

Sketch of Spillways at Dam of Lake Henry, Hazlewood Way Co. Miss. Sept 29, 1951 Approx. Scale 1/4" = 1'

E. S. Lofaro

Soil Conservation Service, Hazlewood, Miss.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

JANET RODGERS AND HELEN STONER

PROFILES AND SECTIONS

JULY 1980 PLATE E-3

APPENDIX F

GEOLOGY

LAKE HENRY DAM

APPENDIX F

GEOLOGY

Lake Henry Dam is located in Wayne County within the Appalachian Plateau Physiographic Province. The most pronounced topographic feature in the area is Camelback Mountain, which is part of the Pocono Plateau Escarpment. The escarpment has a well-defined, southwestward trend from Camelback Mountain, but it is irregular between Camelback Mountain and Mt. Pocono, which lies to the north. Streams east of the escarpment drain directly to the Delaware River, while those to the west drain to the Lehigh River.

The Pocono Plateau Section lies to the west of the escarpment. This area is relatively flat, with local relief seldom exceeding 100 feet. The topography has been greatly influenced by continental glaciation. Many features were created by deposition of glacial materials. The entire plateau lacks well-developed drainage.

East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by pre-glacial erosional topography with locally-thick glacial deposits. Local relief is generally 100 to 300 feet.

Bedrock units of the sections described above are the lithified sediments of offshore marine, marginal marine, deltaic environments, and fluvial environments associated with the Devonian Period. These units include siltstones of the Mahantango Formation, siltstones and shales of the Trimmers Rock Formation, and seven mapped members of the Catskill Formation. These members include sandstones, siltstones, and shales of the Towamensing member; sandstone, siltstone and shale of the Walcksville Member; sandstones, siltstones and shale of the Beaverdam Run Member; sandstone and shale in the Long Run Member; sandstones and conglomerates in the Packerton Member; sandstones and some conglomerates in the Poplar Gap Member; and sandstones and conglomerates in the Duncannon Member.

Lake Henry Dam is underlain by the Poplar Gap Member of the Catskill Formation. The Poplar Gap Member is

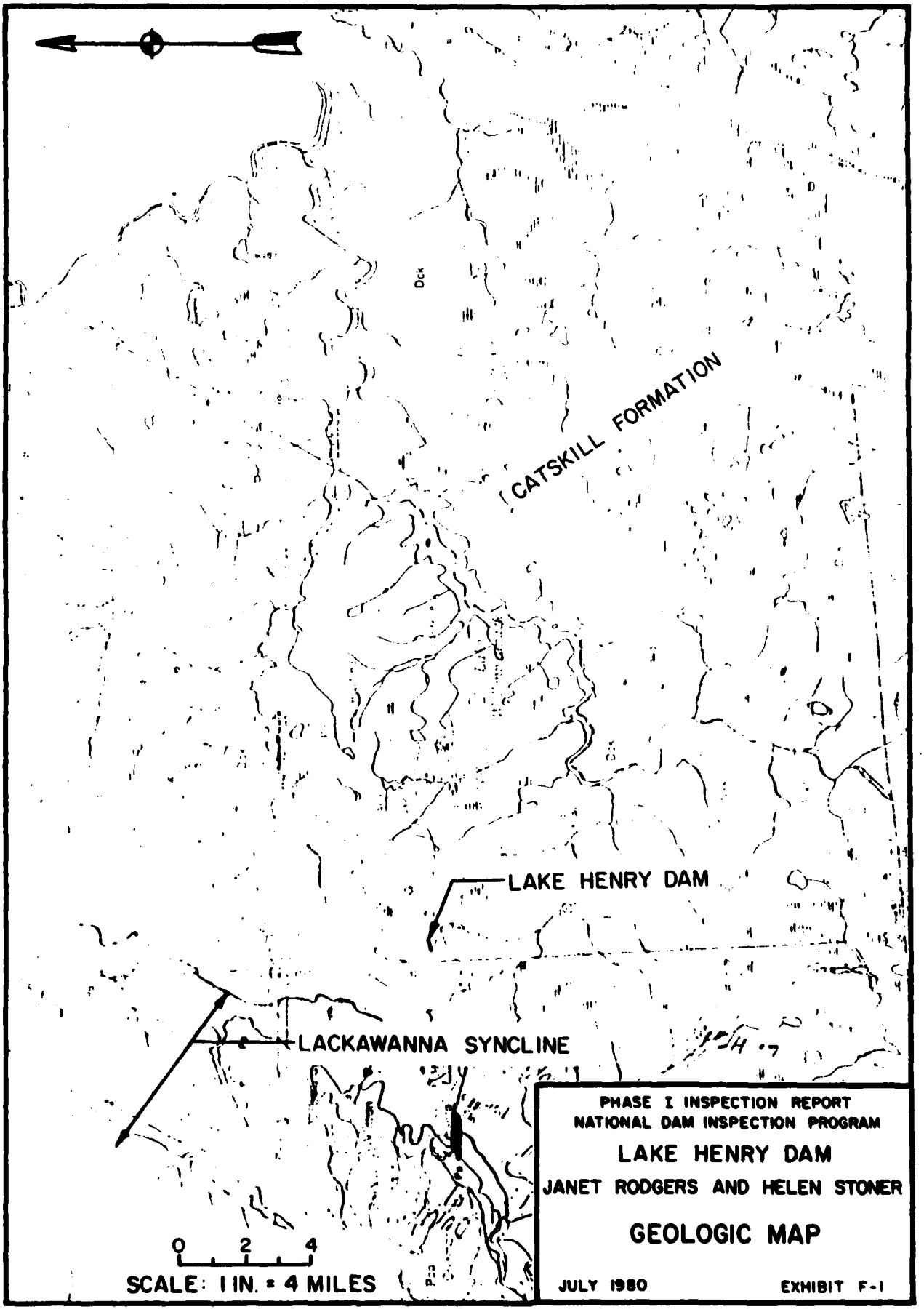
predominantly a gray sandstone and conglomeratic sandstone with interbedded siltstones and shales. Sandstones present are thick-bedded, fine-to coarse-grained and exhibit very low primary porosity due to a clay and silica matrix. Effective porosity results from fractures and parting planes.

Conglomeratic sandstone occurs primarily as concentrates of sub-round to round quartz pebbles. The siltstones and shales at the site are thin-bedded and also have low porosity.

The rocks are well-indurated and generally are not susceptible to slope failure; however, the presence of well-developed bedding and joint planes will result in some rockfall from vertical and high-angle cut slopes.

Bedrock is entirely overlain by glacial till of Late Wisconsin Age. This till is an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is generally derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 5 to 75 feet.

Bedrock is visible at the main spillway channel. No bedrock is visible near the embankment; foundation conditions at the embankment are unknown.



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NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

JANET RODGERS AND HELEN STONER

GEOLOGIC MAP

JULY 1980 EXHIBIT F-1